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Pilot Judgment Training and Evaluation Volume I

Embry-Riddle Aeronautical University
Regional Airport, Daytona Beach, FL 32014

June 1982

Technical Summary

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NOTICE

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Volume II - Student Manual
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16. Abstract This document summarizes the implementation and results of both the optimization process and the small-scale evaluation experiment performed upon the judgment training program materials. During optimization, the Student Manual underwent three separate iterations and the Instructor Manual underwent two iterations. This resulted in eleven modifications to the Student Manual and seven major modifications to the Instructor Manual.

The evaluation experiment was conducted using three groups. The experimental group received a written pretest, judgment ground and flight training, a written posttest, and an observation flight at the completion of the training. The flight control group received only the post-training observation flight. The academic control group received the written pretest and posttest along with the experimental group. The resulting data indicated statistically significant differences between the performance of experimental and control group subjects. This was true both in the acquisition of judgment concepts as measured by written tests and in the skills performance as measured during the observation flights.

Two limitations to the judgment program's generalizability are the relative homogenity of the subjects and the compressed nature of the training time utilized.

The associated volumes of the document are Volume II - Student Manual, and Volume III-Instructor Manual.

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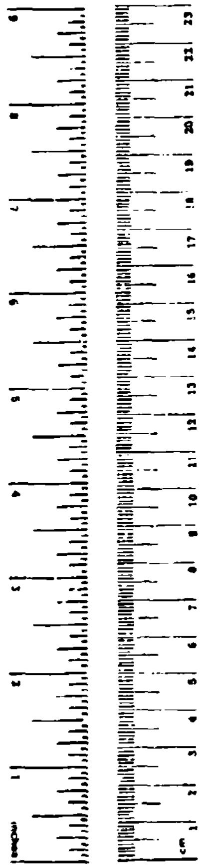
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

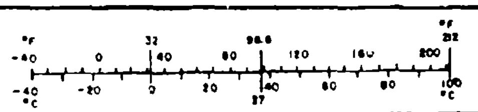
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

National Transportation Safety Board (NTSB) accident statistics reveal that a large portion of civil aviation accidents are in part related to poor flying judgment. In recognition of the seriousness of this problem, the Federal Aviation Administration (FAA) in 1976 initiated a multi-phase program to improve the judgment-making abilities of civil aviation pilots. The first phase of the program resulted in a report by researchers at the University of Illinois which contained a review of judgment-related literature, a definition of pilot judgment and the conclusion that the training and evaluation of pilot judgment was feasible.

The Aviation Research Center of Embry-Riddle Aeronautical University (E-RAU) in October of 1980 completed a second phase of the pilot judgment study for the FAA. Course materials were developed to deliver a judgment training program to civil aviation pilots. The program was designed to be used by flight instructors in the field without additional support materials.

E-RAU was later assigned the additional tasks of optimizing the judgment training materials and of conducting a small-scale validation experiment. The effort was conducted under the Airmen Research Program in general aviation, initiated by the FAA Technical Center.

This volume summarizes the implementation and the results of the optimization process and the small-scale evaluation experiment performed upon optimized training program materials. This effort was carried out by the Aviation Research Center of Embry-Riddle Aeronautical University under contract number DOT-FA-79NA-6040. Dr. Alan Diehl was the Contracting Officer's Technical Representative for the FAA's Office of Aviation Medicine. The project was also monitored by the FAA's Office of Flight Operations.

The contents of this three volume document are based on work which was accomplished during E-RAU's initial effort and which was conceived and conducted under the guidance of Dr. Jerome I. Berlin, then Director of Aviation Research Center at E-RAU. Original versions of the Student Manual and the Instructor Manual were conceptualized and written during this effort by a team of scientists at the E-RAU Aviation Research Center with consulting assistance from Social Science Research Associates (SSRA). Authors included Dr. Berlin of E-RAU, Mr. Eric V. Gruber (E-RAU), Dr. James W. Mills (SSRA), Dr. Phillip K. Jensen (SSRA), Dr. James M. O'Kane (SSRA) and Dr. Charles W. Holmes (E-RAU).

The optimization of the two manuals and the evaluation experiment reported here were conducted by a team of Aviation Research Center personnel at E-RAU under the direction of Dr. Charles W. Holmes. Data collection was conducted principally by Mr. James R. Lau. Principle editor of the optimized Student and Instructor Manuals was Mr. Eric V. Gruber, with assistance from Dr. Holmes, Mr. Lau and Mr. Fred Schwieg. Assistance with training portions of the evaluation experiment was provided by E-RAU flight instructors Mr. Niels Christensen, Mr. Jim Zurales and Mr. Mike Shephard.

This Technical Summary was prepared by Dr. Holmes, Mr. Lau, and Mr. Gruber. Drs. James W. Mills, Phillip K. Jensen and James M. O'Kane of SSRA provided consultation regarding the statistical analyses.

USER COMMENTARY.

These pilot judgment training program materials are both new and innovative. It is hoped that user experiences and commentary will be reported to the FAA offices involved in this research. Please address your written commentary to one or both of the FAA offices listed below.

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EXECUTIVE SUMMARY

National Transportation Safety Board accident statistics (reference 1) reveal that a large portion of civil aviation accidents are related to poor flying judgment as a primary or contributing cause. Therefore, a multi-phase research program was initiated by the Federal Aviation Administration (FAA) in 1976 to answer questions concerning the definition, nature and possible means for improvement of pilot judgment in general aviation. Researchers at the Aviation Research Laboratory of the University of Illinois completed an initial study in 1977. This study provided a comprehensive review of literature and produced a definition of pilot judgment. The study concluded that the improvement and the evaluation of pilot judgment was feasible, and it described a broad approach for teaching and evaluating pilot judgment.

Embry-Riddle Aeronautical University (E-RAU) was assigned the task of developing, optimizing and evaluating judgment training materials for a small-scale validation experiment, using student pilots and flight instructors affiliated with the University. This document outlines the concepts upon which the training materials are based, it describes the optimization process which yielded the present Student and Instructor Manuals (volumes II and III of this document); and it summarizes the method and results of the experiment performed to evaluate their effectiveness.

PURPOSE.

The purposes of the study were:

1. to optimize the training materials by improving the presentation of the information while maintaining or improving the learning results;

2. to demonstrate the effectiveness of the program in a small-scale experiment; and

3. to develop, and to test on a small scale, methods and procedures for the objective measurement of pilot judgment.

CONCEPTS AND IMPLEMENTATION.

The course materials are contained in two volumes. The Student Manual (volume II) contains 18 lessons of instructional material and companion worksheets. The Student Manual presents new terms and concepts which have been especially designed to lead the

student into modified patterns of thinking. These include the definition of pilot judgment, "the three subject areas," "the six action ways," "the poor judgment sequence chain," and "the three mental processes of safe flight." In addition, newly derived behavioral aspects of pilot judgment are introduced. These include "the five hazardous thought patterns," "antidotes" for the hazardous thoughts, and techniques for identifying and reducing stress.

The Instructor Manual (volume III) reviews the contents of the Student Manual, describes the instructional delivery of the program's conceptual and behavioral aspects, and presents two sets of lessons for the instructor to conduct during flight training. It also contains instructional management materials for the individual flight instructor as well as the training supervisor.

The "Concepts and Implementation" section of this Technical Summary specifies each new concept and behavioral aspect that the training materials contain. Two learning theories, behavior modification and facilitation, were used in the program's design. An outline of these two theories and a discussion of their role in the implementation of the instruction are also presented in this section.

OPTIMIZATION.

APPROACH. Optimization of the Student Manual was conducted in two stages using small groups of E-RAU flight students. During the first stage, three students read and reviewed the manual. In the second stage, six students performed a similar review. Modifications and revisions were made following each iteration in response to the deficiencies uncovered. A third iteration was conducted concurrently with the evaluation experiment and was performed by the 27 subjects in the experimental group. However, only minor changes were made following the exercise.

Optimization of the Instructor Manual was accomplished in two stages. First, two E-RAU senior flight instructors read and critically reviewed the manual. This information, plus changes made to the Student Manual during its second optimization, provided the basis for a first revision. The second stage was conducted concurrently with the evaluation experiment, and minor revisions were made based on information gathered from the three flight instructors involved in that effort.

RESULTS. The Student Manual underwent alterations throughout its content. Eleven major changes, described in the body of this report, were incorporated and the time required for the average student to complete the manual was verified to be just over seven hours. The Instructor Manual also underwent major revisions, and seven major changes were incorporated. An additional unit containing necessary items to support the instructor's management of the instruction was added, and conformity was maintained to the final optimized Student Manual.

EVALUATION.

METHOD. The experimental approach consisted of three groups of 27 subjects each. The experimental group received an academic pretest, judgment ground and flight training, an academic posttest, and an observation flight at the completion of the training program. The flight control group received only the observation flight. The academic control group received the same written pretest and posttest as the experimental group.

The subjects were all students at Embry-Riddle Aeronautical University (E-RAU) Daytona Beach, Florida. They were randomly selected from volunteers enrolled in the University's FA 103-Basic Flight course, which includes students who have met the requirements for solo flight and are engaged in flight training leading to the attainment of the private pilot certificate. Attrition for the three groups was minimal, with 26 subjects completing the activities from the experimental group, 24 from the flight control group and 25 from the academic control group.

Two instructors were employed and trained by the E-RAU Aviation Research Center project team to deliver the training program to the experimental group and to conduct the observation flights which followed it.

Judgment training for the experimental group was completed in approximately three weeks. Ground training consisted of study of the Student Manual with guidance from the students' judgment program flight instructor. Flight training consisted of three 2-hour flights during which the judgment program flight instructor administered in-flight exercises from the Instructor Manual units IV and V.

DATA COLLECTION. Data were collected from the two types of activities, a written pretest and posttest, and a post-training observation flight. The written pretest and posttest were identical and were administered to the experimental group and the academic control group. The test consisted of five sections which included knowledge of general pilot judgment concepts, three types of pilot activity scenario analyses, and recall of judgment terminology presented by the Student Manual. The observation flight was of approximately one and three-quarters hours duration, and it was administered to both the experimental group and the flight control group. All subjects were directed to fly a standardized route and activity scenario by the flight instructor administering the flight. A trained observer in the rear seat of the aircraft observed the subjects during 20 specific judgment situations for good judgment or poor judgment responses. At the conclusion of the observation flight, subjects in both groups completed a short interview which provided subjective data regarding experiment participation. Subjects in the experimental group also answered questions regarding the effectiveness of the Pilot Judgment Training Program.

RESULTS. Data from written testing and the observation flights indicated statistically significant differences between the performances of the experimental group and control group subjects.

For the written tests, results from each of the five sections were analyzed using analysis of variance (ANOVA). Results of the analysis indicated the scores of the experimental group were significantly higher than those of the control group on all sections of the posttest found to be valid and relevant. Even the portion of the test with general pilot judgment concepts that avoided the specific terminology of the program indicated higher scores for the experimental group. The results for the section dealing with factor importance ratings were not analyzed since this section was found to have questionable validity as a measurement instrument.

Analysis of the observation flight was conducted using a one-way analysis of variance. The results of this test were again statistically significant ($p < 0.001$) meaning that the probability is less than one in one thousand that the difference is due to chance alone. The experimental group demonstrated a markedly better performance on the post-training observation flight than did the control group.

Subjective data collected in the interviews following the observation flights indicated generally favorable reactions from subjects. All subjects from the experimental group indicated a belief that the training would be of value to them in their future flying, and many mentioned that they had recognized poor judgment situations during flying done outside the judgment program.

DISCUSSION. The data indicated statistically significant differences between the performance of experimental and control group subjects. This was true both in the acquisition of judgment concepts and in the skills performance as measured during judgment flight situations. The experimental group evidenced an increase in knowledge of the judgment concepts while the control group showed no significant change. Also, the experimental group evidenced a markedly better performance on the post-treatment judgment skills observation flight than did the control group.

One of the major tenets of the program is that students must master judgment concepts before those concepts can be applied in judgment flight situations. Concepts of the judgment training were not only taught during the ground school, but were constantly reinforced during flight training and during preflight and postflight briefings. Although it cannot be said that a direct causal relationship was proven to exist between the judgment ground training and the improvement of judgment in flight as measured by the observation flight, it appears evident that the integrated ground training and flight training did have a positive effect on subject performance in judgment flight situations.

The subjects participating in the experimental group held strongly positive attitudes about the benefits of the judgment training program at the experiment's conclusion. A substantial majority of the group responded favorably to all the questions posed by the attitude questionnaire. They reported that: 1) they would pay greater attention to judgment concepts in their own future flying, 2) they believed the program to be "a good idea," and 3) they would like to see judgment training material be part of the required studies for a private pilot license.

Two potential limitations to the generalizability of the program's potential effects as indicated by these results are noted. First, the subjects involved were a relatively homogeneous group. This gives rise to the question as to how the program might transfer to a more heterogeneous group of subjects. Second, the training period was compressed, covering only one month. A conclusion cannot be drawn as to how the program might function when integrated into the training schedule of an airport based flight school where the training period for student pilots usually ranges from six to twelve months.

CONCLUSIONS.

Results of the experiment indicate that the implementation of the optimized manuals had a positive effect on the judgment-making abilities of subjects in the experimental group, as measured by an observation flight and a written test. It is hypothesized that similar results would be obtained in the overall general aviation population, resulting in improved pilot judgment-making abilities.

INTRODUCTION

BACKGROUND.

National Transportation Safety Board accident statistics reveal that a large portion of civil aviation accidents are in part related to poor flying judgment. During the period from 1973 to 1977 the pilot-in-command was listed as the cause or a related factor in 83 percent of all general aviation accidents and as the cause or a related factor in 88 percent of the fatal accidents that occurred during the same period (reference 1). Since these causal statistics may include the influence of more than one factor, it is at best difficult for the researcher to identify accidents which were caused solely by pilot "judgment."

Another difficulty confronting serious attempts to investigate the judgment aspects of pilot behavior has been the lack of a precise, functional definition of "pilot judgment." Further, there has been uncertainty about whether or not a pilot's judgment abilities can be improved through training.

Recognizing the continuing safety issue of poor pilot judgment, as well as its associated difficulties and uncertainties, the Federal Aviation Administration (FAA) initiated a multi-phase research program in 1976 to seek answers to the problem. Undertaking the first phase of research, the Aviation Research Laboratory of the University of Illinois conducted a study entitled, Judgment Evaluation and Instruction in Civil Pilot Training (reference 2). That study contained a comprehensive review of literature relating to judgment training in aviation and other related fields. In addition, the study produced the following results:

1. a definition of pilot judgment;

2. a conclusion that the improvement and the evaluation of a pilot's judgment is feasible; and

3. the development of a broad approach for teaching and evaluating judgment.

With the work of the University of Illinois providing background information and guidance, the Aviation Research Center of Embry-Riddle Aeronautical University (E-RAU) completed a second-phase study. This effort resulted in innovative training materials for improving the judgment-making abilities of primary flight student pilots, as well as a systematic approach for use by flight instructors to administer the judgment training.

PURPOSE.

The current study had three major purposes. The first was to develop optimized pilot judgment training and evaluation course materials. The optimization procedure was oriented toward improving the presentation of the information, while maintaining or improving the learning results. A second purpose was to demonstrate the effectiveness of the program in a small-scale experiment. It was not the intent of this research to conduct a full-scale validation of the Pilot Judgment Training Program, but to provide information upon which a decision to initiate another phase of the study may be based. The third purpose was to develop and to test, on a small scale, guidelines and procedures for the objective measurement of pilot judgment in both ground and flight training environments.

CONCEPTS AND IMPLEMENTATION

Using new concepts and constructs, a training program was created which endeavored to meet the following terminal objectives:

1. To produce a program that was practical, easily applied and effective in producing the desired response from the students. The contracting office of the FAA specifically discouraged the use of elaborate training aids such as audio-visual materials and simulators during this early phase of the program.

2. To design the program so that it would achieve meaningful integration into the present FAA approved ground and flight school curriculum and so that it would not significantly impact the amount of training time required to obtain a private pilot license.

3. To increase the student pilot's knowledge and understanding of himself by teaching him to better recognize and identify hazardous human behavior patterns.

4. To teach the student pilot to recognize, analyze and evaluate factors which influence judgment in regard to safe flight.

5. To train the student pilot to recognize and to cope with potentially hazardous conditions such as the presence of hazardous thinking, poor judgment chains and high stress.

6. To introduce positive changes into the flight instructor's own teaching behavior and attitudes.

The course materials are contained in two volumes. The Student Manual contains the instructional material and companion worksheets which provide the students with practice activities and progress indicators. The Student Manual contains 18 lessons which are divided into three units. Unit I presents terms and concepts

designed to both develop modified patterns of thinking, and to give students and instructors the most objective means possible for discussing pilot behavior. Unit II addresses behavioral aspects of judgment, including hazardous thoughts and stress. Unit III relates the learning of units I and II to actual flight situations using scenarios based on actual pilot accident reports.

The Instructor Manual explains how the flight instructor is to present judgment training to the students, outlines the content of the Student Manual, presents two sets of lessons for the instructor to conduct during flight training, and contains support materials for the instructor.

PILOT JUDGMENT DEFINED.

In the effort to capture the salient aspects of pilot judgment in a precise definition, judgment in and of itself was not seen as a problem. Rather, it was the actions that pilots took based upon their poor judgments that created problems. Since the training program was therefore to address pilot actions (i.e., pilot judgment behaviors), it was first necessary to establish a specific, functional definition of pilot judgment in this context.

The National Transportation Safety Board (NTSB) classifies aircraft accidents by detailed cause factors. Among these are factors pertaining to judgment, all of which are under the broad cause of "pilot" and include such quantifiable factors as speed, distance, altitude, and clearance. In the context used in the NTSB accident causes, the pilot failed to estimate one or more of these factors correctly. While this ability to estimate the value of certain factors can be measured, a definition of "judgment" within this context is too limited for the purpose of this study.

Jensen and Benel (reference 2) analyzed all accidents occurring during the 1970 - 1974 time period in which the pilot in command was listed as the cause or a related factor. They classified these pilot-caused accidents into one of three behavioral categories -- procedural, perceptual-motor, or decisional activities. They found that a majority of the nonfatal pilot-caused accidents (56 percent) were the result of faulty perceptual-motor behavior. This category included such factors as failure to maintain flying speed and misjudgment of distance, speed, altitude, or clearance. A majority of the fatal pilot-caused accidents (51 percent) resulted from faulty decisional behavior. They found the most significant factors in these cases to be the familiar "continued VFR (visual flight rules) into known adverse weather" and "inadequate preflight planning or preparation." It became clear that this is the sort of faulty decisional behavior that the pilot judgment training program, and hence the operational definition of judgment, must address.

Webster's New Collegiate Dictionary (reference 3), defines judgment as "the process of forming an opinion or evaluation by discerning and comparing". In Dictionary of Behavioral Science (reference 4), judgment is defined as "a critical evaluation of a person, object, or situation" (p. 208). English and English (reference 5) define judgment as "a critical evaluation of a person or a situation. It includes the processes of appreciation, comparison, and appraisal of values" (p. 282). However, S.I. Hayakawa (reference 6) describes judgment in the context which is best suited for this study. Judgment, according to Hayakawa, is "sense (his emphasis) applied to the making of decisions, especially correct decisions" (p. 69). Hayakawa describes sense as referring to "...rational perception accompanied by feeling. Used this way it suggests an intense awareness and realization of the stimuli to which it is responding ... The word is commonly applied to the ability to act effectively in any given situation" (p. 690). For the first time, an outcome of judgment is specified -- a decision to act. The decision is made based upon the awareness and realization of the stimuli, or factors, which are forcing the decision. Judgment, therefore, is not an end; it is the process through which a decision is made to take some sort of action.

In making the decision, the pilot must consider all of the factors which have, or should have, influence upon his or her decision-making process. These factors shall include all pilot, aircraft, and environmental considerations. Based upon these considerations and the earlier findings of Jensen and Benel's first-phase study, pilot judgment is defined as follows:

> Pilot judgment is the mental process by which the pilot recognizes, analyzes, and evaluates information regarding himself, the aircraft, and the outside environment. The final step in the process is to make a decision pertaining to the safe operation of the aircraft and to implement the decision in a timely manner.

Thus it can be said that if a pilot properly recognizes, analyzes, and evaluates the factors, and subsequently makes the "proper" decision and implements it in a timely manner, then he or she exercises good judgment. If he or she does not properly recognize, analyze, or evaluate the factors, and subsequently makes a poor decision which leads to "improper" or untimely action, then he or she has exercised poor judgment.

CONCEPTUAL AND BEHAVIORAL ASPECTS OF TRAINING.

The Student Manual presents new terms and concepts which have been especially designed to lead the student into modified patterns of thinking. In addition, newly derived behavioral aspects of pilot judgment are introduced to the student. The Instructor Manual

contains a complete presentation of the intent and instructional delivery of these conceptual and behavioral aspects. The following section specifies the program's unique instructional elements to give the reader a basic understanding of the training materials which are discussed within this volume.

THE THREE SUBJECT AREAS. Each poor judgment made by the pilot can be categorized to involve one or a combination of three specific subject areas: the pilot himself (Pilot), the aircraft and its subsystems (Aircraft), and the outside environment (Environment).

The Pilot subject area concerns the pilot's state of health, competency in a given situation, level of fatigue and any other factors that may effect his performance.

The Aircraft subject area includes consideration with respect to the aircraft's airworthiness, its powerplant, and its equipment as well as performance criteria such as weight and balance and runway requirements.

The Environment subject area concerns not only items such as the weather, take-off conditions, airfield altitude and temperature, but also outside information inputs such as weather briefings (or lack thereof), ATC instructions, and other considerations.

THE SIX ACTION WAYS. Nearly 600 NTSB accident briefs were examined to determine how pilots carry out the actions resulting from their decisions. It became obvious that pilots implemented their decisions in six ways, and that these "action ways" could be grouped in three pairs:

1. DO - NO DO

2. UNDER DO - OVER DO

3. EARLY DO - LATE DO

The actions ways are defined as follows:

1. DO: The pilot did something he or she should not have done.

2. NO DO: The pilot did not do something he or she should have done.

3. UNDER DO: The pilot did not do enough when he or she should have done more.

4. OVER DO: The pilot did too much when he or she should have done less.

5. EARLY DO: The pilot acted too early when he or she should have delayed acting.

6. LATE DO: The pilot acted too late when he or she should have acted earlier.

These action ways are associated only with poor judgment. In order to exercise good judgment it would be necessary for the pilot to perform the action required and only that action, perform the action only to the degree necessary, and to perform the action on time.

THE POOR JUDGMENT BEHAVIOR CHAIN. Ontiveros, Spangler, and Sulzer (reference 7) stated that most accidents result from a combination of circumstances, rather than a single cause such as pilot error, aircraft defect, or environmental stress. They also emphasized that an aircraft accident is the end result of this causal chain. Similarly, it can be said that most accidents do not result from one error in judgment. An accident would be more likely to occur as a result of a series of errors in judgment pertaining to pilot proficiency or experience, aircraft condition, or stress caused by the outside environment. This series of errors in judgment is called the poor judgment behavior chain (PJ chain).

It is impossible for accident investigations by the NTSB to precisely establish the PJ chain of behaviors which lead to a pilot being involved in an accident. This is especially true in fatal accidents. It is therefore impossible to establish a pattern for the PJ chain on an empirical basis. The following principles of the PJ chain are therefore *a priori*.

1. One poor judgment increases the probability that another poor judgment will follow. Since judgments are made on information about oneself, the aircraft, or the environment, the pilot is more likely to make a poor judgment if the input factors are not accurate. One poor judgment provides an erroneous bit of information which the pilot must consider when making subsequent judgments.

2. The more poor judgments made in sequence, the more probable that others will continue to follow. The reasoning for this principle is the same as that in the previous principle, except that it is concerned with multiple poor judgments in sequence. The more erroneous information used by the pilot to make judgments, the more likely it is that the pilot will make subsequent poor judgments.

3. As the PJ chain grows, the alternatives for safe flight decrease. It is *a priori* that if a pilot selects one alternative among several, the option to select the remaining alternatives may be lost. For example, if a pilot makes a poor judgment to fly through a hazardous weather area, the alternative to

circumnavigate the weather is lost once severe weather is encountered.

4. <u>The longer the PJ chain becomes, the more probable it is that disaster will occur</u>. As the PJ chain grows longer, fewer and fewer alternatives for safe flight are available to the pilot. As the alternatives for safe flight become fewer, the greater the chance becomes that an accident will occur.

It is imperative that the PJ chain be broken as early as possible. Since pilot judgment is defined as a mental process by which pilots recognize, analyze, and evaluate information, it is reasonable to assume that pilots can be trained in the process.

<u>BREAKING THE PJ CHAIN</u>. The single most important first step in breaking the PJ chain is recognition by the pilot that he or she has made a poor judgment. If recognition of the poor judgment is not made, there is little chance to prevent the subsequent recurrence of poor judgments. In order to recognize that a poor judgment has been made, the pilot must receive evaluative or corrective information about his or her judgment process He or she must be able to perceive the results of actions based on previous decisions, and use this information as input factors in subsequent judgment processes. The pilot must, in other words, recognize and use <u>feedback</u>. A pilot generally receives feedback from two sources:

1. The pilot's own senses, and

2. An outside observer.

Since good judgment is a <u>learned</u> process, it is generally necessary that feedback initially comes from an outside observer (i.e., the instructor). As judgment training continues, the pilot will learn to obtain feedback from his or her own senses. Prior interpretation of feedback is sometimes difficult in that the pilot is often hesitant to admit that he or she has made an error in judgment. Yet, recognition of poor judgment is necessary in order to break the PJ chain as quickly as possible. The following steps are prescribed in order to help pilots break the PJ chain:

1. Recognize that a poor judgment has been made (utilize feedback). Admit the error in judgment.

2. Check for personal stress that could allow the PJ chain to continue.

3. Engage in problem resolving (PR) to correct the problem that resulted from the poor judgment.

4. Search for other poor judgments. The pilot must remember that poor judgments tend to occur in chains, and must be sure that he or she has broken the PJ chain.

5. Diagnose the original poor judgment to provide oneself the feedback needed to avoid making a similar poor judgment in the future.

THE THREE MENTAL PROCESSES OF SAFE FLIGHT. The mental processes as used here are applied to safe flight. However, they may in fact be applied to any activity or process. People do certain things automatically, they solve problems, and they review on-going processes in order to assess their current status. The three mental processes are defined as follows:

1. Automatic Reaction (AR) is the mode of thinking that allows the pilot to maintain control of the aircraft while simultaneously engaging in other activities. The pilot maintains heading and altitude by making small, automatic adjustments in power and attitude. The pilot can simultaneously perform other tasks such as talking on the radio and, in the case of the proficient pilot, taking care of in-flight emergencies. The pilot finds that, with practice, the need to "think about" what to do will decline and eventually be eliminated as his or her skills become Automatic Reactions.

2. Problem Resolving (PR) is the mode of thinking that helps a pilot overcome undesirable situations by means of a systematic process. The systematic process takes place in three steps. In step one, the pilot recognizes, analyzes, and defines a problem. In step two, the pilot considers the methods to solve the problem and the possible outcomes of the possible solutions. In step three, the pilot applies the selected solution to the best of his or her ability. In problem resolving, one must work through a process; in automatic reaction, one just does.

3. Repeated Reviewing (RR) is the mode of thinking that allows the pilot to be continuously aware of all the factors (pilot/aircraft/environment) that affect safe flight. The pilot is continuously trying to anticipate which factor will require that his or her mental activities be engaged in PR or AR. By repeated reviewing, the pilot can keep an awareness of all the conditions, from weather conditions to aircraft performance to the pilot's own state of health, that contribute to safe flight or have the potential of leading to disaster.

THE FIVE HAZARDOUS THOUGHT PATTERNS. Jensen and Benel (reference 2) stated that every decision that a pilot makes is influenced by physiological, psychological and social pressures which are virtually impossible to measure at the time the decision is made. In addition, self-image and the need to maintain that image externally can effect the pilot's judgment. The question remained as to the identity of thought patterns which accompany

the type of self-image and the type of external image manifested by the pilot displaying poor judgment. It was necessary to identify specific thought patterns which would make a pilot willing to violate regulations, extend safety margins, exceed legal limitations, or attempt to operate an aircraft in conditions beyond his or her capabilities. In other words, what are the thought patterns which cause pilots to exhibit what Jensen and Benel have labeled "irrational pilot judgment?"

It was postulated that if these thought patterns could be identified, then pilots could be trained to recognize them in their own thinking and to apply corrective actions. Little prior research was found in which such thought patterns were described. Thus, it was found appropriate to consult experts in the psychological and sociological sciences to obtain informed opinions on the nature of such hazardous thought patterns. This resulted in the identification of five thought patterns and the assigning of descriptive names for these thoughts. Descriptions of the thoughts which were identified are contained in the following paragraphs.

1. *Anti-authority*. This is the thought pattern found in people who resent the control of their actions by any outside authority. The general thought is "Do not tell *me*! No one can tell *me* what to do." A person having this thought will disregard rules and procedures if they prevent him or her from doing things his or her own way. They might ignore a parking sign (Do not tell *me* where to park!) or not follow the prescribed preflight checklist (Do not tell *me* what to do to get my aircraft ready to fly!). The key to the behavior is that the person is resentful of established rules, regulations, and procedures, and will tend to ignore advice, even though it is well-founded.

2. *Impulsivity*. This is the thought pattern found in people who, when facing a moment of decision, feel that they must do something and do it quickly. This thought is characterized in the student manual as, "Do something - quickly!" The person having this thought does not stop to think about what to do, does not explore the implications of what he or she is about to do, or does not examine a set of alternatives and select the best one. This person simply does the first thing that comes to mind.

3. *Invulnerability*. This is the thought pattern of people who feel that nothing disastrous could happen to them. The thought is characterized in the student manual by the statement, "It won't happen to *me*!" Serious illness, floods, fires, and volcano eruptions are extremely remote to people having this thought. They know that such disasters happen, but never feel that they will be directly affected. People who think this way are more likely to take chances and unwise risks. They feel that accidents will happen to other people, but not to them.

4. Macho. This is the thought pattern of people who are always trying to prove that they are better than others. The thought is characterized in the student manual by the statement, "I can do it!" They feel that others should be careful, but not themselves. They feel that they can always manage to handle the difficult situations. They prove themselves by taking risks and try to impress others by acting dangerously. While the macho thought pattern is generally considered to be a characteristic of male thinking, it is not so in this case. In the sense used here, macho is more closely associated with overconfidence, but goes beyond the meaning of that word in that the individual attempts to do difficult things in order to gain the admiration of others. In this sense, the characteristic is not restricted to males.

5. External control. People who have this thought pattern feel that they can do very little, if anything, to control what happens. This thought is characterized in the student manual by the question, "What's the use?" When things go well, it is attributed to good luck. When things go badly, it is attributed to bad luck, or it is generally the fault of someone else. People having this thought may at times exhibit a degree of paranoia. When in school, for example, they might attribute good grades to an easy examination, but may consider poor grades to be the fault of an unfair teacher. Since they feel that whatever they do makes no difference, they tend to be passive. Since they feel that they can exercise little or no control over situations, they do not make decisions themselves. They leave decision-making responsibilities to others.

SELF-ASSESSMENT INVENTORY. An assessment instrument was designed to highlight the hazardous thought patterns of the students. While this test is based on real data, modification and validation will be needed before it can serve as a diagnostic instrument. The administration of the assessment inventory to a large number of pilots would provide normative data for use on the profile. Such work would be a major undertaking in its own right. For the current program, the most advantageous use of the assessment scales is to motivate the student, help him to identify his own response tendencies, and serve as an introduction to the five hazardous thoughts.

ANTIDOTES FOR HAZARDOUS THOUGHTS. The mere recognition of hazardous thoughts was not considered a sufficient means of altering a pilot's tendency to make poor judgments. In addition to recognizing the presence of hazardous thinking, pilots needed to be taught to take corrective actions against such thoughts. The judgment training materials teach students to remove the effect of a hazardous thought by substituting a good judgment thought for the hazardous one. This set of substitute thoughts is called the antidotes for hazardous thoughts. The value of the

antidotes goes beyond simple substitution for hazardous thoughts. It is a tenet of behavior modification that a change of thoughts will promote a change in actions. Thus, teaching pilots to think the antidote thoughts is an important device in altering not only the poor judgment thinking of pilots, but also the actions which result from such thinking.

IDENTIFYING AND REDUCING STRESS. An overstressed state of mind can increase the likelihood of poor judgments. In order to teach pilots to effectively cope with the effects of too much stress, a preliminary need was identified for a means to assess the amount of stress being experienced at any given time.

The subjective units of discomfort (SUD) system is used as a means for identifying stress. It was developed by Wolpe (reference 8) as a subjective anxiety scale to measure a person's anxiety responses to specific situations. Use of the system is an important first step in reducing stress in that it provides the student a way of gauging anxiety or tension. The system is introduced by having the student think of the situation which led to the worst anxiety he has experienced, or a situation which could lead to the worst anxiety he or she could imagine, and assign to this situation the number 100. Next, the student is asked to think of being absolutely calm and call this state zero. All other states of anxiety may then be placed in a relative position on this scale. The student is then presented with a number of situations, and asked to rate the SUD level of each situation. This information is then used by the student in developing a scale for assessing his or her own stress level.

When stress levels are identified as being excessive, the student is taught to employ a method for reducing stress. A simple deep breath technique is provided as the primary relaxation method. A more elaborate method called "Progressive Relaxation" is also provided as an appendix to the lesson on stress.

IMPLEMENTATION.

Instructions for implementing the judgment training program are contained in the Instructor Manual, volume III of this report. However, it is appropriate to briefly discuss here the educational theory underlying the implementation design. Two general learning theories are used in the judgment training program: behavior modification and facilitation.

References for behavior modification are numerous. A concise overview of the process may be found in Chaplin and Krawiec (reference 9). Briefly, behavior modification is the application of principles of learning to achieve changes in motivation, skills and performance. Components of behavior modification relevant to the manuals are stimulus, response and reinforcement. The stimulus is something which causes a person to take some sort of action. The action is the response. If a pilot experiences an

engine failure on takeoff (the stimulus), he or she will then accomplish the appropriate emergency procedure (the response). The purpose of behavior modification is to train the person to make the proper response through positive reinforcement. If a person takes some sort of action, and something pleasant happens to the person as a result of the action, then that person is likely to repeat that action in the future. In this case, the action is said to be reinforced. If something unpleasant happens as a result of some action, then that action is said to be punished and the person is likely to cease taking the action. A problem with punishment is that it does not encourage a person to take a proper action; it only encourages a person to cease an action, whether it is proper or improper.

Facilitation, simply defined, is the process by which one person, who is the trainer "A," helps another person "B," grow or learn in directions which best suit "B" and are chosen by "B." The classic paper describing the conditions of facilitation was authored by Carl Rogers (reference 10). An overview of facilitation as a component in humanistic educational theory may be found in Chapter 2 of Stanford and Roark (reference 11). Facilitation underlies an associated theory of learning which affirms that experiential learning is the area in which significant change occurs. Experiential learning has the quality of personal involvement. A person's feelings are coupled with the cognitive aspects of being in the learning event. This results in a difference in the behavior, the attitudes and, according to Rogers (reference 12), perhaps even the personality of the learner.

As was stated previously, extensive use was made of behavior modification and facilitation in designing the program. To elucidate how these learning theories were employed, the following paragraphs quote the principles of judgment instruction from the Instructor Manual. Each principle is then followed by a brief statement about its relevancy to behavior modification or to facilitation.

"1. The Student Manual is simple to understand, and it is repetitive. This is for two beneficial reasons: 1) The simplicity produces frequent success experiences giving the student a continuing exposure to positive reinforcement; 2) the repetition builds good judgment habits and refreshes the memory so that information can be readily recalled in a variety of circumstances, not just in the context in which it was learned."

This is behavior modification. Frequent positive reinforcement is a particularly strong behavior modification device.

"2. The Student Manual presents numerous true stories to stimulate the student's interest in and appreciation for good pilot judgment. Discussions of these stories and similar ones from the instructor's personal experience are important for developing the student's judgment."

This is facilitation. The instructor is encouraging or facilitating the student to make use of information learned by the student from the Student Manual.

"3. The instructor profoundly affects the student as a role model and as an opinion shaper. The instructor's attitudes to safe flying and to the judgment training material may influence the student's judgment more than does the content of the flight training program."

The student's exposure to the flight instructor is experiential learning, and it is dependent upon the instructor being a good facilitator of attitude development. Citing many case studies, management consultant J. Sterling Livingston concludes that the first year is a critical period of learning for new trainees (reference 13). He states that a young person's first manager is likely to be the <u>most influential</u> person in his or her career. If this manager is unable or unwilling to help the young trainee develop skills necessary to perform effectively, the trainee will set lower standards for himself than he is capable of achieving. His self-image will be impaired, and he is likely to develop negative attitudes toward his job, his supervisor, and even his career in business. If, on the other hand, his manager helps him achieve his maximum potential, the new trainee will build the foundation for a successful career. While Sterling's work focuses on the industrial manager, it can be argued that the flight instructor is also a manager. As such, the instructor's effectiveness is reflected in the student's performance and self-image.

"4. Instruction is greatly improved when the instructor acts as a coach and consistently uses the principles of behavior modification."

The Instructor Manual makes an overt attempt in the introduction to encourage the instructor to employ behavior modification techniques.

"5. Use of the special judgment concepts in conversations with the student effectively focuses instruction on judgment related training, encourages proper use of behavior modification, and increases the student's ability to provide the self-generated feedback upon which good judgment depends."

The concepts presented by unit I are tools to help the student and the instructor deal with judgment in the training environment. Additionally, they are devices to motivate changes in specific behaviors through the use of behavior modification.

"6. Knowing how to recognize and respond to hazardous thinking and high stress is very important to exercising good pilot judgment. The instructor encourages the student to develop these skills, but never attempts to analyze or to modify the student's personality."

The encouraging efforts of the instructor are intended to facilitate the student's positive experiences with identifying his own hazardous thinking and high stress levels.

"7. The student learns concepts and behavioral techniques, then repeatedly applies this learning to relevant flight situations during ground and flight training. The five application lessons and the in-flight experiential activities are purposely spaced throughout the standard private pilot training course in order to build new behavior habits through repeated reinforcement and constant student involvement. Having a student merely 'learn about' the judgment concepts and behavioral aspects cannot be expected to change pilot judgment. Therefore, an intensive learning format which teaches only the content of the Student Manual over a few days is not acceptable. Spaced practice that includes repetition and feedback with positive reinforcement is essential to the success of this judgment training program."

This summary statement refers to both behavior modification and facilitation. The repeated practice with feedback is a behavior modification reinforcement technique. The emphasis on going beyond merely learning about the judgment materials stems from facilitation. The applications lessons (Student Manual unit III) and the two series of in-flight lessons (Instructor Manual units IV and V) are specifically designed to provide the experiential opportunities necessary for facilitative learning to take place.

OPTIMIZATION

The optimization effort was undertaken to accomplish two objectives: (1) to improve the text on a lesson-by-lesson basis to most clearly and succinctly accomplish learning objectives, and (2) to rearrange the lesson sequence and sections of individual lessons to produce the most effective learning track.

APPROACH.

OPTIMIZATION OF THE STUDENT MANUAL. The optimization effort was conducted in three stages. In the first stage, three E-RAU beginning level flight students read through the initial draft of the Student Manual and completed all of the exercises contained therein. While they were completing the manual, the students were observed by Aviation Research Center personnel. They were also interviewed after completing each section of the manual, and again

after completing the entire manual. The purpose of the observation and interviews was to determine whether there were (1) sections of the text which the students found to be confusing; (2) sections which seemed too long, too elementary or too repetitious; or (3) sections which seemed to be incorrectly or poorly sequenced. A first revision of the Student Manual was then made based upon information gained during this process.

In the second stage, six E-RAU flight students read the lessons and completed the exercises in the revised draft Student Manual which resulted from stage one. As they worked through the manual, the students recorded the time it took them to complete each lesson. Also, they noted the sections which they found to be confusing, repetitive, or overly simplistic. The Student Manual was then revised a second time based upon information gathered during this small group study.

The third stage of optimization was conducted concurrently with the evaluation effort. The 27 subjects in the evaluation experimental group were given instructions to make notes in the margins of their Student Manuals wherever they discovered something they believed to be incorrect, confusing or inappropriate. They were also asked to offer their subjective opinions regarding the Student Manual. The notes and commentaries of these 27 subjects were collated and summarized. This summary was then used to revise the Student Manual a third and final time. Since the manual submitted with this report should be like the manual used in the validation effort, substantial revisions were not made during this stage.

OPTIMIZATION OF THE INSTRUCTOR MANUAL. Optimization of the initial draft of the Instructor Manual was accomplished in two stages. The first stage was comprised of two steps. First, two E-RAU senior flight instructors read the draft Instructor Manual to determine whether the instructions contained in the manual were of sufficient detail to enable effective presentation of the judgment lessons. The instructors indicated unclear passages, confusing directions, or any other deficiencies as they read through the manual. Also, the instructors made any recommendations that they thought would lead to general improvement in it. The second step involved making the Instructor Manual compatible with the newly revised Student Manual. The Student Manual was reviewed for changes which required corresponding revisions in the Instructor Manual to bring the two into agreement. The Instructor Manual was then revised based upon the flight instructor commentary and the review of the Student Manual.

The second stage of optimizing the Instructor Manual was conducted concurrently with the evaluation effort, and was based on information gathered from the three flight instructors involved in that effort. As they conducted the training, the instructors made notes on the appropriateness of the Instructor Manual as a guide

for administering each judgment lesson. Also, the instructors were interviewed periodically during, and immediately following completion of the training to gain their subjective opinions regarding validity of the Instructor Manual. The instructors' notes and their interview comments then formed the basis for the second stage of optimization. As with the Student Manual, substantial changes were not made during this stage to avoid discrepancies between the manual evaluated and the manual submitted with this report.

RESULTS.

The Student Manual underwent alterations throughout its content and eleven major changes were incorporated. The Instructor Manual also underwent major revisions, and seven major changes were incorporated.

The time required for the average student to complete the manual was verified to be just over seven hours. This is below the range of eight to ten hours that was targeted at the outset of the optimization effort. Completion time data collected during the optimization effort can be found in appendix A.

EVALUATION EXPERIMENT

METHOD.

EXPERIMENTAL SETTING. The experiment was conducted using students of Embry-Riddle Aeronautical University as subjects. All activities took place on E-RAU's campus at the Daytona Beach (Florida) Regional Airport. Judgment training was provided by two flight instructors who were employees of the Aviation Research Center. Subjects in the experimental group completed judgment ground training as well as judgment flight training. Other students were used as controls for both the ground school and flight portions of the experiment. The Cessna 172 aircraft used in the experiment were furnished by the Aviation Research Center.

EXPERIMENTAL APPROACH. The major purpose of this study was to demonstrate the effectiveness of the optimized student and instructor pilot judgment training materials in a small scale experiment. The experimental approach (figure 1) consisted of three groups - an experimental (treatment) group and two control groups. The experimental group received an academic pretest, judgment ground and flight training, an academic posttest, and an observation flight at the completion of the training program. The first control group (group Cf) was the flight control group and received only the observation flight at the end of the experiment. The second control group (group Ca) was the academic control group and received the written pretest and written posttest.

GROUP	N	PRETEST	TREATMENT ACADEMIC	TREATMENT FLIGHT	POSTTEST	OBSERVATION FLIGHT
Experimental (E)	27	X	X	X	X	X
Control (Cf)	27					X
Control (Ca)	27	X			X	

FIGURE 1. EXPERIMENTAL APPROACH

Use of the pretest-posttest control group design outlined by Campbell and Stanley (reference 14), for the academic portion of the experiment, provided measures of the acquisition by the experimental group of the judgment concepts. The design also controlled for differences which may have been due to experiential learning occurring during a student's regular course of study.

The posttest-only control group design (reference 14), was used for the flight portion of the experiment for three reasons. First, it could be reasonably assumed that students in the experimental and flight control groups were equivalent at the start of the experiment, as they were all enrolled in the same course at E-RAU. Second, the internal validity consideration of sensitizing the subjects to the treatment by giving them a pre-treatment observation flight was avoided. Third, time and resource constraints prohibited administering an additional observation flight to 54 subjects.

Flight training for the experimental group consisted of three flights during which subjects were trained in the application of previously learned judgment concepts in actual flight situations. A description of the flight training activities is contained in appendix B. Subjects in groups E and Cf were administered an observation flight following the training. (See appendix C for a description of the observation flight.) Performances of the subjects during the observation flight were then compared to determine whether any statistically significant differences existed between the two groups following judgment training.

Ground training in the judgment concepts consisted of supervised study utilizing the Student Manual. Performance of the experimental group (E) was compared with the performance of the academic control group (Ca) both prior to, and after training had been completed. Performance was measured by identical written pretests and posttests. (Refer to appendix D for a reproduction of the test instrument, and refer to appendix E for test answer key.)

The primary statistical test used in comparing means and standard deviations for the written portion (academic pretest and academic posttest) of the judgment ground training was analysis of variance (ANOVA). The primary statistical test used in comparing means and standard deviations for the flight portion of the judgment training was one-way ANOVA. The use of these tests is described below in the Results section.

SUBJECTS. The 81 subjects were randomly selected from student volunteers currently enrolled in E-RAU flight programs. Letters inviting students to participate in the experiment were sent to all 221 students enrolled in the FA 103-Basic Flight course for the fall 1981 trimester. Students in the FA 103 course have met the requirements for solo flight and have completed the private pilot ground school course (AS 100-Foundations of Aeronautics) at E-RAU.

The mean age of the subjects completing the experiment was 19.12 years. Their mean academic grade point average was 2.96 on a four point scale (4.0 = "A"). All but four of the subjects completing the experiment were males. Only two of the subjects were not American citizens.

All subjects were paid student wages for their time during the experiment. This pay totaled $60.00 for each subject in group E and $10.00 for each subject in groups Cf and Ca. Those who were involved in the flight portions of the experiment were not charged for their flight time.

SELECTION AND GROUP ASSIGNMENT. Of the 221 students in the target population, 112 of the students volunteered for the experiment. The subjects were randomly selected and assigned to one of three groups of 27 students each. In order to completely randomize the selection and assignment process, the application forms of all volunteers were assigned a number in no predetermined order. A random number generator was then used to select students for the experiment. The subject having the number matching the first random number was assigned to group E. The subject having the number matching the second random number was assigned to group Ca; the third to group Cf; the fourth to group E, and so on. The selection process was repeated until the required 81 subjects, with ten alternates, were selected.

ATTRITION. Of the 81 students originally chosen for the experiment, there were five who did not start. They were replaced from the pool of alternates by random selection. This number included four students who did not show up for their first scheduled activity and one student who withdrew before his first activity due to a personal emergency. Of the 27 students in the experimental group who started the experiment, 26 completed their assigned activities. One student was unable to complete the observation flight for personal reasons. There were 24 students

in the flight control group and 25 students in the academic control group who completed the experiment. Attrition in these two groups was due to scheduling difficulties.

INSTRUCTORS. Two flight instructors, both of whom were employees of the Aviation Research Center, were used to deliver both the ground and flight judgment training. The instructors were trained to administer the program by research center staff before the experiment began. The ground training of the instructors in judgment concepts consisted of supervised study of the Student Manual and the delivery methods contained in the Instructor Manual. Training instructors in how to deliver the judgment program during flight increments was also conducted by project staff and included at least three practice flights with E-RAU students. The major objective of this training was to standardize the instructors' delivery of the judgment training materials. The 4 students used in the instructor standardization process were chosen from the original pool of research volunteers, but they did not participate as subjects in the experiment.

TRAINING PROGRAM COMPONENTS. Subjects in the experimental group participated in a supervised study program using the optimized Student Manual as a text. The program was administered by the flight instructors who used the optimized Instructor Manual as their guide. The purpose of this supervision was to assure mastery of judgment concepts and terminology by the subjects. The terminology is considered an integral part of the judgment program in that it promotes good judgment behaviors. Subjects had to complete specific sections of the Student Manual before flight training lessons could be delivered. The training schedule for both the ground school and flight portions of the experiment is contained in appendix F.

Judgment flight training, as administered to the experimental group, consisted of three flights of approximately two hours each. The subjects were assigned to a flight instructor who monitored their progress in the written (concept) material and delivered their flight instruction. The subjects remained with the same instructor throughout the training portion of the experiment. The training flights were integrated into the judgment concept training schedule to provide for optimum transfer of conceptual skills to actual flight situations. During the flights, subjects were instructed in the application of the mental processes of the safe flight, action ways, avoidance of hazardous thoughts, and methods to break poor judgment chains. They were also given opportunities to demonstrate their judgment-making abilities in various in-flight judgment situations presented by the instructors. Each of the flights consisted of approximately three lessons concentrating on the use of specific judgment concepts, and between seven and ten judgment situations. Refer to the Instructor Manual for a list of situations that could be chosen by the instructor. (Appendix B includes a description of a typical judgment training flight).

DATA COLLECTION.

PRETEST/POSTTEST. A written pretest (appendix D) was administered to both the experimental and academic control groups prior to the beginning of the judgment program. To ensure testing consistency, the same test was used as a posttest measure and administered to both groups at the conclusion of the judgment training.

The test consisted of the following five sections:

1. Judgment Concepts - Nonjargon. This section tested the subject's knowledge of the concepts contained in the Student Manual without using the specific terminology of the judgment training program.

2. Scer rio Analysis. This section tested the ability of the subject .o identify poor judgment behaviors of a pilot after reading a scenario describing that pilot's flight.

3. Scenario Analysis - Factor Importance and Certainty Rating. In this section, the subject was asked to specify which of the factors in the previous scenarios was the most important in leading up to the incident, and to apply a rating to indicate how sure he or she was of the answer.

4. Action Ways. This section of the test assessed the ability of the subject to identify the ways in which pilots in various situations implemented poor judgment decisions.

5. Judgment Concepts - Specific Terminology. This section tested the subject's recall of the terminology contained in the judgment training program.

OBSERVATION FLIGHT. Objective measures of judgment-making behaviors were obtained during an observation flight administered to groups Cf and E following the latter's judgment training. During the observation flights, the subjects were placed in 20 judgment situations. Their performances (poor or good judgment) in response to the situations were recorded by an impartial observer. Observable critical behaviors that constituted the correct response to each situation were specified by experienced instructor pilots. Failure of the subject to demonstrate the required behavior was recorded as a judgment error. The judgment situation checklist, containing the situations used in the observation flight, is in appendix C.

In order to place the subjects at ease during the observation flight, they were briefed that the flight was being conducted to observe instructional techniques in an experimental pilot judgment training program. The observer emphasized to all subjects that they were not being given a "flight check" and that information gained about their flying performance would be kept confidential from E-RAU flight instructors and other University academic

personnel. The subjects were also told that for any decisions to be made during the flight, they were to make those decisions as if they were the pilot-in-command. The instructor would, at times, give route directions and suggest maneuvers to be performed; but, otherwise the subject was in charge of the flight. Subjects were also briefed that in the event of a real emergency, the instructor would take control of the aircraft. The subject, instructor, and observer used headsets to facilitate the observation process.

The two observers and two instructors were standardized in the observation flight procedures during two practice flights using E-RAU students who were not involved in the experiment. The two flight instructors used in the observation flights were the same instructors who delivered the training. However, to equalize the apprehension which may have been experienced by subjects in the flight control group flying with an unfamiliar instructor, subjects in the experimental group were scheduled to fly their observation flight with the other instructor. Observers were members of the Aviation Research Center staff. The observers and the flight instructors were unaware of the identity of subjects with regard to experimental or flight control group. A description of specific observation flight activities is contained in appendix C. Instructional techniques and procedures used in judgment flight training and the observation flights were reviewed by E-RAU Flight Standards personnel and were found to be within the bounds of safe flight instructional procedures. At the conclusion of the observation flight, subjects in both groups completed a short interview which provided subjective data regarding experiment participation. The interviewer was an Aviation Research Center staff member unfamiliar to the subjects.

RESULTS.

Two methods were used to objectively evaluate the effectiveness of the judgment program. The first method involved a written test to determine how well the subjects had mastered the concepts contained in the Student Manual. The second method consisted of an observation flight during which data were collected on the judgment-making behaviors of the subjects in various situations. A brief description of statistical analysis procedures used is contained in appendix G.

WRITTEN TEST. The written test was administered to all subjects in group E (experimental) and group Ca (academic control). The test was divided into five sections which included the knowledge of general pilot judgment concepts (section I), good or poor judgment scenario analysis (section II), importance and certainty rating scenarios (section III), action ways scenarios (section IV), and judgment training terminology (section V).

Data for each of the five sections of the written tests were analyzed using an analysis of variance for a mixed design with one

between subject (control vs. experimental) and one within subject (pretest vs. posttest) variable. In this design the primary interest is in the interaction between the two variables. A successful training program should result in a marked shift in the experimental group from pretest to posttest with little if any improvement in the control group over the same time.

While it is possible to look at the main effects of control vs. experimental groups and pretest vs. posttest scores, caution must be used. The possibility exists with a strong interaction that apparently significant differences in main effects may really be artifacts as an examination of the means will reveal. The scores are grouped into two sets, those that account for between subjects variance, that is variance accounted for by group, and those that account for within subjects variance, that is, variance accounted for by time or pretest/posttest differences. In the second set of scores, the interaction effect (group x test) is the factor in which we are most interested. The lowest line in each set of scores represents the error variance due to individual subject differences. (subjects-within-groups and test x subjects-within--groups).

Results for section I of the written test (general pilot judgment concepts) are displayed in tables 1 and 2. In table 1 it can be seen that the means of both groups increased, although the difference in group E was much greater. In designs of this type one would expect the experimental group scores to improve and the control group scores to remain the same. Some small, but real improvement may have occurred in both groups as a result of non-experimental events between the pretest and posttest.

The ANOVA (table 2) examines these results. The F value for groups of 9.307 is statistically significant ($p < 0.01$) indicating a difference between groups E and Ca. The difference in scores attributed to the effect of the pretest/posttest is shown by the F value for test ($F = 58.809$) and is statistically significant ($p < 0.001$). The most important F value is the one which represents the interaction of the above two factors (group and test). The F value for group x test ($F = 22.481$) is also statistically significant ($p < 0.001$).

Data for the remaining four sections of the written test were analyzed in the same manner.

TABLE 1. MEANS AND STANDARD DEVIATIONS
FOR WRITTEN TEST SECTION I

		Group E	Group Ca	Row Marginals
Pretest	Mean	4.808	5.120	4.964
Posttest	Mean	8.538	6.000	7.269
Column Marginals	Mean	6.673	5.560	6.117
	SD	1.086	1.495	
	N	26	25	

TABLE 2. SUMMARY OF ANALYSIS OF VARIANCE
OF WRITTEN TEST RESULTS, SECTION I,
GROUPS AND GROUP X TEST

Source	df	MS	F
Between-Subjects			
Groups	1	31.581	9.307**
Subjects-within-groups	49	3.393	
Within-Subjects			
Test	1	135.475	58.809***
Group x Test	1	51.789	22.481***
Test x Subjects-within-Groups	49	2.304	
Total	101	4.931	

** $p < 0.01$

*** $p < 0.001$

Results for section II of the written test (good or poor judgment scenario analysis) are presented in tables 3 and 4. Again the relevant test is the interaction effect of group x test, and in this case is significant ($p < 0.05$).

TABLE 3. MEANS AND STANDARD DEVIATIONS FOR WRITTEN TEST SECTION II

		Group E	Group Ca	Row Marginals
Pretest	Mean	5.038	5.120	5.079
Posttest	Mean	5.692	5.040	5.366
Column Marginals	Mean	5.365	5.080	5.223
	SD	0.901	0.976	
	N	26	25	

TABLE 4. SUMMARY OF ANALYSIS OF VARIANCE OF WRITTEN TEST RESULTS, SECTION II, GROUPS AND GROUP X TEST

Source	df	MS	F
Between-Subjects			
Groups	1	2.076	1.180****
Subjects-within-groups	49	1.760	
Within-Subjects			
Test	1	2.098	2.580****
Group x Test	1	3.432	4.218*
Test x Subjects-within-Groups	49	0.814	
Total	101	1.324	

**** NS

* $p < 0.05$

Data for section III of the written test (importance and certainty rating scenarios) are presented in tables 5 and 6. As can be seen by the F value for the interaction effect of group x test (F = 0.003), the differences among the groups were not significant. In the scenario analysis portion of the test, subjects were to rate the importance of various factors from a scenario on a scale of zero to ten. The answers were to be compared to scores of a panel of 12 experts who had rated the same scenario (See appendix H for panel of experts information). Items were chosen for use on which both a high level of importance and a high level of consensus (as indicated by a standard deviation of no more than 1.5 in the distribution of scores) were recorded by the experts.

TABLE 5. MEANS AND STANDARD DEVIATIONS FOR WRITTEN TEST SECTION III

		Group E	Group Ca	Row Marginals
Pretest	Mean	9.441	9.427	9.434
Posttest	Mean	9.545	9.536	9.541
Column Marginals	Mean	9.493	9.481	9.487
	SD	0.497	0.417	
	N	26	25	

TABLE 6. SUMMARY OF ANALYSIS OF VARIANCE OF WRITTEN TEST RESULTS, SECTION III, GROUPS AND GROUP X TEST

Source	df	MS	F
Between-Subjects			
Groups	1	0.003	0.008****
Subjects-within-groups	49	0.422	
Within-Subjects			
Test	1	0.291	3.116****
Group x Test	1	0.000	0.003****
Test x Subjects-within-Groups	49	0.093	
Total	101	0.253	

**** NS

The subjects, when analyzing the same scenario, also indicated that these same items were extremely important. This situation represents what may be called the "ceiling effect." That is, all responses were at the top of the scale. The test, therefore, could not discriminate among the subjects as to which ones were making the better analysis.

The results of the factor importance rating and the certainty scale rating were deemed of little use in determining performance of the experimental and control groups. The twin problems of little expert agreement on the majority of the questions and the ceiling effect that occurred on the remaining questions suggest that more time and effort are necessary to refine and validate this type of questioning. Since the certainty scale rating responses were contingent upon the merits of the factor importance rating, this section of testing was also disregarded. The responses to the certainty rating scale were, therefore, not analyzed.

Results of the analysis of the written test scores, section IV (action ways scenarios), are shown in tables 7 and 8. Again, the F value for the interaction effect is statistically significant ($p < 0.01$).

TABLE 7. MEANS AND STANDARD DEVIATIONS FOR WRITTEN TEST SECTION IV

		Group E	Group Ca	Row Marginals
Pretest	Mean	4.538	4.480	4.509
Posttest	Mean	6.962	5.200	6.081
Column Marginals	Mean	5.750	4.840	5.295
	SD	1.227	0.910	
	N	26	25	

TABLE 8. SUMMARY OF ANALYSIS OF VARIANCE OF WRITTEN TEST RESULTS, SECTION IV, GROUPS AND GROUP X TEST

Source	df	MS	F
Between-Subjects			
Groups	1	21.108	8.996**
Subjects-within-groups	49	2.346	
Within-Subjects			
Test	1	62.954	40.222***
Group x Test	1	18.483	11.809**
Test x Subjects-within-Groups	49	1.565	
Total	101	2.913	

** $p < 0.01$

*** $p < 0.001$

Results of the analysis of scores for the written test, section V, the judgment terminology test, are displayed in tables 9 and 10. The F value of 341.834 is extremely high due to the criterion referenced nature of this portion of the test. Subjects in the experimental group, because they were exposed to a substantial amount of material which subjects in the control group were not, would be expected to outperform the control group subjects on such a test of specific "jargon" material.

TABLE 9. MEANS AND STANDARD DEVIATIONS FOR WRITTEN TEST SECTION V

		Group E	Group Ca	Row Marginals
Pretest	Mean	8.038	6.960	7.499
Posttest	Mean	32.308	7.040	19.674
Column Marginals	Mean	20.173	7.000	13.587
	SD	2.456	2.458	
	N	26	25	

TABLE 10. SUMMARY OF ANALYSIS OF VARIANCE OF WRITTEN TEST RESULTS, SECTION V, GROUPS AND GROUP X TEST

Source	df	MS	F
Between-Subjects			
Groups	1	4423.301	366.132***
Subjects-within-groups	49	12.081	
Within-Subjects			
Test	1	3778.177	346.371***
Group x Test	1	3728.690	341.834***
Test x Subjects-within-Groups	49	10.908	
Total	101	129.274	

*** $p < 0.001$

In general, subjects in the experimental group performed significantly better on the written posttest than did students in the control group, demonstrating that these students did learn the materials covered in the judgment training program. Even the portion of the test that avoided the specific terminology of the program indicated greater improvement for the experimental group. This pattern was repeated uniformly in the four sections where interpretation was possible.

OBSERVATION FLIGHT. Analysis of the observation flight was conducted using a one-way analysis of variance. The relevant data are presented in tables 11 and 12. These data are based on the twenty situations described earlier and represent the percent of situations in which the subjects responded correctly. The scores reported by the observer and pilot were pooled for this analysis since a correlation of 0.96 was obtained between them. The high correlation is due to the objective nature in which the judgment situations were constructed and observed.

TABLE 11. MEANS AND STANDARD DEVIATIONS FOR THE OBSERVATION FLIGHT (20 SITUATIONS)

	Group E	Group Cf
Mean	74.365	57.521
SD	12.409	10.878
N	26	24

TABLE 12. SUMMARY OF ANALYSIS OF VARIANCE OF OBSERVATION FLIGHT RESULTS (20 SITUATIONS)

Source	df	MS	F
Between-Subjects			
Groups	1	3541.056	25.867***
Subjects-within-groups	48	136.897	
Total	49	206.370	

*** $p < 0.001$

The results of this test were again statistically significant. There was concern that some experimental flight group subjects had been exposed during their judgment training to some of the same situations that were tested on the observation flight. Seven of the judgment situations used during the observation flight had also been used during training, but had not been seen by all subjects. It can be argued that the training of specific judgment situations is part of the criterion referenced nature of the judgment training program, and therefore should be included in the analysis. However, in an effort to eliminate any possible bias, the seven situations were eliminated and the remaining 13 situations analyzed. Results of this analysis are reported in tables 13 and 14.

TABLE 13. MEANS AND STANDARD DEVIATIONS FOR THE OBSERVATION FLIGHT (13 SITUATIONS)

	Group E	Group Cf
Mean	69.365	56.125
SD	14.757	13.332
N	26	24

TABLE 14. SUMMARY OF ANALYSIS OF VARIANCE OF OBSERVATION FLIGHT RESULTS (13 SITUATIONS)

Source	df	MS	F
Between-Subjects			
Groups	1	2187.835	11.017**
Subjects-within-groups	48	198.592	
Total	49	239.189	

** $p < 0.01$

As would be expected, the F value is slightly smaller due to the fewer measures involved in the analysis and the removal of the source of variance of some of the students previously exposed to judgment flight situations. With these factors eliminated from the analysis, the results were still statistically significant ($p < 0.002$).

As another check against possible bias due to previous exposure of students in the experimental group to judgment situations, a correlation was calculated between the number of situations students had been exposed to prior to the observation flight, and their score on the observation flight. This correlation ($r = 0.017$) was not significant, indicating very little relation between previous situations seen and score on the observation flight.

An attempt was also made to determine whether there was a correlation between the subjects cumulative grade point average in college and any of the measures on either the written or flight observation flight tests. There was none.

SUBJECTIVE DATA. The subjects in groups E and Cf completed an interview following their observation flight. Most of the interviews were done immediatel after the flight. In instances where the observation flight te..inated after the close of office hours, the interviews were done the following business day. Each interview was conducted by a member of the Aviation Research Center staff who was not previously involved with the training or observation of the subjects. All interviews were conducted in a staff scientist's office at the Aviation Research Center.

The interview process produced four sets of data:

1. Demographic data for the subjects in groups E and Cf;

2. Subjective response data from subjects in group E summarizing their opinions about various aspects of the experimental training program;

3. Subjective response data from groups E and Cf summarizing their opinions about various aspects of the observation flight; and,

4. Subjective response data from group E subjects regarding personal attitudes about the perceived benefits of pilot judgment training.

Demographic data described in item 1 above as well as demographic data for group Ca is reported in appendix I. The data described in items 2 and 3 above were collected by oral questioning of the subjects by the interviewer. Data for items 2 and 3 are summarized in tables 15, 16 and 17 below. Appendix I presents a sample of the interview form employed for the questioning (see page 1-5).

The data regarding attitudes about judgment training benefits, described above in item 4, was collected by having the subjects in group E fill out a student attitude questionnaire sheet. This data is summarized in table 18 below. A reproduction of the questionnaire form appears in appendix I on page I-8.

TABLE 15. GROUP E RESPONSES TO QUESTIONS ABOUT THE EXPERIMENTAL TRAINING

Question	Response Summaries (N = 26)
Was the effort required to complete the manual too time consuming?	No subjects affirmed that Student Manual was too time consuming. Eight stated it seemed too redundant.
Was the time spent in judgment flight training? a. too little? b. too much? c. about right?	Too little = 3 Too much = 1 About right = 22
How would you like to see the program changed?	Nine subjects suggested that there be no change. Others indicated minor changes. (See next question.)
(Continued to Next Page)	

TABLE 15. GROUP E RESPONSES TO QUESTIONS REGARDING THE EXPERIMENTAL TRAINING (Continued)

Which areas would you emphasize? a. more b. less	Need to be emphasized more: stress reduction = 4 hazardous thoughts = 4 judgment situations = 4 14 subjects indicated that they would like to see less redundancy.
Has this program had any impact on your judgment-making behaviors thus far? What were the circumstances?	1 subject indicated that the program had no impact on judgment-making behaviors. 25 subjects indicated that the program heightened their awareness and that they began to recognize poor judgment situations even in flight outside of the program.
Were you asked anything on the written test that was not in the Student Manual?	6 subjects responded that there was material on the test that was not covered in the manual.
Did you understand all of the questions?	4 subjects indicated having not understood questions on the test.
Did you have ample opportunity to meet with your instructor?	1 subject indicated inadequate time with the instructor.
How do you feel about each of the following as they related to pilot judgment? a. Hazardous thoughts and antidotes b. Action ways c. Mental processes of safe flight. d. Subject areas	a. All subjects thought that these related well to pilot judgment. b. High importance = 7 Little importance = 3 Medium importance = 16 c. All were neutral. d. Responded favorably = 6 while some found it difficult to relate to the judgment situations and others thought there was too much emphasis on this.
Do you feel this program will be valuable to you in your future flying? Why?	All indicated that the program would be of value. Many said that their awareness was increased along with greater anticipation. Others indicated an improvement in their attitude.

TABLE 16. GROUP E RESPONSES TO QUESTIONS REGARDING THE OBSERVATION FLIGHT

Question	Response Summary (N = 26)
Had you heard about the check-flight before?	Only one subject indicated having previous knowledge about the observation flight. What was heard was of the nature, "Watch out, it's a trick."
In situations where the instructor indicated you made a poor judgment did you think you were coerced or forced into the maneuver?	One subject thought he was coerced. This may be due to the unique role of the instructor during the observation flight.
Were there any situations you thought were unfair or overly confusing?	1 subject was confused about the situation involving a turn during a simulated engine failure.
Were there any maneuvers or procedures requested of you with which you were not familiar?	4 subjects were not familiar with S-turns. 1 subject did not understand the endurance situation. 3 subjects were not familiar with cross country operations.

TABLE 17. GROUP Cf RESPONSES TO QUESTIONS ABOUT THE OBSERVATION FLIGHT

Question	Response Summary (N = 24)
Had you heard about the check-flight before?	Only 1 subject indicated having heard about the observation flight. What was heard was of the nature "Watch out, it's a trick."
In situations where the instructor indicated you made a poor judgment did you think you were coerced or forced into the maneuver?	4 subjects indicated that they thought they may have been coerced into a maneuver. This may have been due to the unique role of the instructor during the observation flight.
Were there any situations you thought were unfair or overly confusing?	1 subject was confused about entry to an airport (used wrong runway). 1 subject was confused during the disturbed approach path.
Were there any maneuvers or procedures requested of you with which you were not familiar?	4 subjects were not familiar with the requested ground reference maneuvers. 1 subject was unfamiliar with control tower procedures and requested base leg pattern entry. 1 subject had not done steep turns. 1 subject had not seen slips to landing.

TABLE 18. GROUP E RESPONSES TO JUDGMENT TRAINING ATTITUDE QUESTIONNAIRE

Questions	Responses: Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
(1) In the future I am going to pay more attention to the judgment concepts covered in my own flying.	73%	27%			
(2) This program as a whole is a good idea.	62%	38%			
(3) I'd like to see material like this included as a requirement for a private pilot license.	38%	38%	19%	4%	
(4) The instructor really kept me aware of judgment factors during the training flights.	50%	38%	12%		
(5) I feel talking about judgment with the instructor is an important part of learning good judgment.	65%	31%			4%
(6) I would have learned just as much about judgment if there were no flying.			4%	50%	46%
(7) The course moved too fast and covered too many concepts.			8%	77%	15%
(8) The stress reduction lesson was helpful.	15%	46%	31%	8%	

DISCUSSION.

The data indicated statistically significant differences between the performance of experimental and control group subjects. This was true both in the acquisition of judgment concepts and in the skills performance as measured during judgment flight situations. The experimental group evidenced an increase in knowledge of the judgment concepts while the control group showed no significant change. Also, the experimental group evidenced a markedly better performance on the post-treatment judgment skills observation flight than did the control group.

One of the major tenets of the program is that students must master judgment concepts before those concepts can be applied in judgment flight situations. Concepts of the judgment training were not only taught during the ground school, but were constantly reinforced during flight training and during preflight and postflight briefings. Although it cannot be said that a direct causal relationship was proven to exist between the judgment ground training and the improvement of judgment in flight as measured by the observation flight, it appears evident that the integrated ground training and flight training did have a positive effect on subject performance in judgment flight situations.

The subjects participating in the experimental group held strongly positive attitudes about the benefits of the judgment training program at the experiment's conclusion. A substantial majority of the group responded favorably to all the questions posed by the attitude questionnaire. They reported that: 1) they would pay greater attention to judgment concepts in their own future flying, 2) they believed the program to be "a good idea," and 3) they would like to see judgment training material be a part of the required studies for a private pilot license.

LIMITATIONS. It is noted that there are limitations to the generalizability of the judgment training program's potential effects as indicated by these treatment results. First, the subjects involved were a somewhat homogenous and unique group. They were all closely grouped by age, the mean being 19.5 years with a range of 17-23 years. They were all full-time college students enrolled in various aviation related degree programs at an exclusively aeronautical university. They were living in an aviation oriented environment 24 hours a day, and it may be surmised that virtually all of them possessed some motivation to become professional members of the aviation community. (See appendix I for a summary of demographic data collected about the subjects.) The question then arises whether or not the treatment would transfer to a more heterogeneous (i.e., age, personality type, environment, motivating factors) group of neophyte flight students.

Second, the training period was of a compressed nature, lasting only one month. This period by no means approximates the usual training time required for a student to obtain a private pilot license. This typically ranges from six to twelve months. Thus no conclusion can be drawn as to whether or not this judgment training program, when integrated into the "normal" training schedule at a fixed-base operator (FBO), will be as effective as in this experiment. In addition, the evaluation measures were obtained immediately after the treatment. The experiment did not investigate the extent to which such training effects the judgment of pilots over an extended period of time. It remains for future studies to investigate the efficacy of judgment training extended throughout the typical student pilot's learning schedule, and the extent to which judgment training concepts and application skills are retained over time.

CONCLUSIONS.

Results of the experiment indicated that the implementation of the optimized student and instructor manuals had a positive effect on the judgment-making abilities of subjects in the experimental group, as measured by an observation flight and a written test. It is hypothesized that similar results would be obtained in the overall general aviation population, resulting in improved pilot judgment-making abilities.

ADDITIONAL EVALUATION APPROACHES

Educational researchers generally identify two types of evaluative research with regard to instructional programs. Lehmann and Mehrens (reference 15) provide a concise description of the two types:

> One may, and should, evaluate a program at several stages. If one evaluates at intermediate stages while changes can still be made in the program, it is called process or formative evaluation. Evaluation at the completion of the program is referred to as summative evaluation. For example, if one has initiated a curriculum or instructional innovation in a school, a systematic attempt should be made to evaluate each stage of the project, improve it as it proceeds on the basis of this evaluation, and then, at the completion of the project, summative evaluation should be conducted. ... All ... curriculum innovations should be systematically evaluated both during the program to incorporate improvements, and at the end to obtain summative (or decision-oriented) evaluation.

The optimization of the training materials and the evaluation experiment reported here represent a very constrained effort at both formative evaluation (optimization of the manuals) and summative evaluation (the small-scale experiment). As noted previously, there are major limitations to the generalizability of the reported results due to the homogeneous character of the limited subject pool and the severely condensed training time. Also, no attempt was made to investigate effectiveness of judgment training over an extended period of time.

The judgment training program presented by these volumes therefore stands in want of further evaluation. Additional formative evaluation of the program, when used by a randomized grouping of student pilot subjects in a typically structured flight training program, may produce evidence dictating additional improvements. Further, a large-scale summative evaluation is essential to producing decision-oriented results indicating the program's enduring benefits to the aviation community.

The evaluation experiment reported here offers one potential evaluation model for discovering the need for further improvements and for providing empirical information about the program's long-term value. Two additional approaches to evaluate the effects of this program are suggested. The first is a study of the student's recall of the pertinent material. The second is a study of post-graduation pilot behaviors.

PERTINENT RECALL APPROACH.

A program is effective only if its effects are lasting. If after a sufficient interval of time following the completion of judgment training, the graduates are again tested on the materials presented in the program, a measure of retention can be obtained. However, the ability to retain and recall material from the program, while a necessary feature of success, is not a sufficient criterion of that success. Mere recall, at a later date, does not indicate how salient or integral that training is in the pilot's thinking process. Six months after graduation we might ask a pilot to name the five hazardous thoughts, and he or she might well be able to do that. But more elaborate testing methodology is needed to determine whether the pilot would have recalled these thoughts without prompting or whether he or she would recall pertinent information in actual flight situations.

ACCIDENT REPORT ANALYSIS. A series of accident reports are prepared. Participants in the program are asked to analyze the reports and to describe what went wrong, how the accident might have been prevented, etc. Actual accident data may be used, but it must be presented in a format that would allow the opportunity to apply the concepts from the training program. Such accident

report analysis would probably best be done at various intervals over a period of time. One possibility is weekly administrations. The last of these analyses would include a series of increasingly specific questions designed to determine the items of learning from the program which, to that point, had remained latent. For example, the pilot might be asked, "Is there anything you learned in your training which helps you understand what contributed to the cause of this accident?"

TV INTERVIEW OBSERVATION AND REACTION. TV tapes are prepared in which an interviewer separately interviews two pilots. The "pilots" may actually be two well-rehearsed actors. In each of the tapes, the pilots differ from one another on an important variable in the training program. For example, one pilot might discuss an instance when he decided to fly under conditions which suggested that he considered himself invulnerable to mishap. The other pilot will discuss a similar situation in which he chose not to fly. In all cases, the presentations are arranged to permit control of such extraneous variables as sequence of presentation and specific actors. The interview must be carefully prepared to conceal the hazardous thought or other element of judgment training that is being presented for testing. After seeing the set of interviews, the test subjects are asked to give their reactions to, and impressions of, the two pilots. The way in which the participants respond becomes an indirect measure of their views. A semantic differential rating form is developed on which the subject rates the two pilots. An effective rating form should result in different ratings for the pilots displaying good judgment and those displaying poor judgment.

PILOT BEHAVIOR APPROACH.

An effective judgment training program should result in different behaviors for the graduates as compared to non-graduates. However, it will be necessary to identify the behaviors which are demonstrative of good judgment prior to implementing the evaluation. A suggested approach is to develop a number of in-flight situations in which pilots are provided opportunities to exercise their judgment-making abilities. Critical actions, or behavior indicating a good judgment response, are then specified for each judgment situation. These critical behaviors must be observable in order to assess the pilot's judgment-making ability. Failure of the pilot to demonstrate the critical behavior constitutes an error in judgment. Pilot judgment is then assessed by comparing overall error rates among groups. Three possible means of measuring pilot judgment behavior follow.

INSTRUCTOR EVALUATION. An objective rating form is developed on which qualified instructors rate the judgment behaviors of student pilots. This form would cover all phases of judgment training.

Periodically, these instructors are asked to rate trainees in each area. Graduates of the program could also be rated by other qualified persons at various time intervals. An analysis of the results should provide evidence about differing pilot behaviors.

INCIDENT REPORTS. Pilots with good judgment should have fewer incidents (accidents and near accidents) than those with poor judgment. A record of incidents involving graduates could be carefully kept for several years.

GENERAL BEHAVIOR REPORTS. A means of periodically interviewing pilots about their flying habits and experiences to elicit a retrospective record of their behavior is designed. The interview is an excellent technique for collecting data of this type. This is particularly true when making formative evaluations.

GENERAL CONSIDERATIONS.

Those seeking a broader discussion of training and performance evaluation methodologies relevant to pilot judgment may wish to refer to Jensen and Benel's report, Judgment Evaluation and Instruction in Civil Pilot Training (reference 2), in particular, pages iv, xi-xiii, 50, and 76-110.

Persons having a professional interest in commenting upon these or other evaluation approaches are invited to contact the FAA in this regard. Please refer to the specific contact information provided in the preface to this volume on page iv.

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APPENDIX A

COMPLETION TIME - STUDENT MANUAL

This table summarizes completion times for experimental group subjects for each of the units in the Student Manual. Subjects were requested to report the times they spent in each unit to their instructor. Data for 23 subjects were complete and are reported here.

Subject Number	Time Taken for UNIT I		Time Taken for UNIT II		Time Taken for UNIT III		Total Time	
	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins
1	2	30	4	-	2	20	8	50
2	1	-	1	15	4	-	6	15
3	-	35	3	6	1	20	5	1
4	-	30	2	50	2	10	5	30
5	-	45	2	30	3	-	6	15
7	-	30	2	35	2	-	5	5
8	-	20	3	-	2	-	5	20
9	1	10	7	-	3	-	11	10
10	-	30	3	45	1	55	6	10
11	1	15	3	50	3	-	8	5
13	-	50	6	25	1	15	8	30
14	1	-	3	-	2	-	6	-
15	-	30	4	50	3	20	8	40
16	-	55	5	5	1	20	7	20
17	-	49	2	26	1	45	5	-
18	-	29	6	20	3	26	10	15
20	1	30	4	-	4	30	10	-
21	-	47	4	15	1	15	6	17
22	1	32	4	20	2	33	8	25
23	1	30	3	45	2	30	7	45
24	-	55	4	-	2	42	7	37
25	1	-	3	30	2	30	7	-
26	-	45	4	32	1	50	7	7
Mean	0	56	3	56	2	25	7	17

APPENDIX B

DESCRIPTION OF FLIGHT TRAINING ACTIVITIES

This appendix contains material from the Instructor Manual describing a sample judgment training flight. For an explanation of the judgment terminology used in this appendix, see pages 4 through 11.

SAMPLE TRAINING MISSION

This is a sample judgment training mission profile. The concept lesson and the behavioral situations to be administered have been selected for the flight and are recorded on the instructor's checklist. All necessary preparation has been completed before the student's expected arrival time.

Concept lesson to be administered:
Transitions using flaps

Judgment situations to be administered:
Preflight - fuel selector screw
Preflight - shoulder harness
Enroute - VFR altitude
Enroute - over water

Instructor Preparation:
Remove fuel selector screw
Stow shoulder harness
Locate available over-water practice area
Locate area of scattered clouds at 3,000 to 8,000 feet

MISSION NARRATIVE

The instructor informs the student they will meet at 2:00 p.m. for a training flight. The student is told to have the aircraft ready to fly. The instructor arrives at the appointed time and verifies that the student has the aircraft ready to fly. The instructor intentionally makes no attempt to release the stowed shoulder harness.

Preflight - Fuel Selector Screw

The student advises the instructor that he discovered the fuel selector screw missing during the preflight check. He found it on the carpet, and used a screwdriver from one of the mechanics to replace the screw. While buckling his seat belt, the instructor offers positive reinforcement for the student's act of good judgment regarding the fuel selector. The instructor comments, "You were very alert to fix the loose fuel selector. Good work." The student also buckles his seat belt but makes no attempt to remove the stowed shoulder harness.

Preflight - Shoulder Harness

The student continues with the preflight. At this time, the instructor says in a non-critical manner, "I notice that you don't have your shoulder harness on. Are you aware of the FARs concerning seat belts?" The student replies affirmatively. The instructor then asks, "What type of poor judgment action way does this represent?" The student answers, "This was a No Do; I should have fastened my shoulder harness, but I did not do it." The instructor gives positive reinforcement (praise, smile) for this correct poor judgment diagnosis, and he adds "Don't let *my* poor judgment influence yours - you must always make your own judgment."

They both then fasten their shoulder harnesses and continue with takeoff preparations. The run-up and takeoff proceed normally. The aircraft is in flight at 2,000 feet AGL in the local practice area. The instructor directs the student to climb to 4,000 feet and "to head out in that direction for some air work" (the instructor points east toward the ocean). The student replies, "Sir, the FARs state that for flights above 3,000 feet AGL on an easterly heading, we must maintain odd thousands plus 500 feet. Wouldn't 5,500 be a better choice?" The instructor compliments the student (positive reinforcement) for recognizing a potential poor judgment situation.

Transitions Using Flaps

The concept lesson is then conducted by the instructor. It is devoted to training in transitions from cruise to minimum controllable flight using various flap settings. Emphasis is placed on developing the student's learning of the automatic reaction (AR) mental processes. The instructor provides positive

reinforcement when appropriate, and when an error occurs, points out the subject areas and action ways in question.

The student is told to establish slow flight at minimum controllable airspeed (MCA), which he does by reducing power and extending flaps, adding power as MCA is neared to avoid a stall. The instructor queries the student, "you are sure we are clear of other traffic in the area?" The student replies, "No, I should have made clearing turns while I was setting up the aircraft." The instructor reinforces this, "Yes, that was a No Do action. You should have been more aware of your environment. What you are doing well however, is understanding and controlling the pitch-power relationship." The student replies, "Yes, I feel I am doing pretty well with that." The instructor then says, "Very good. Now retract the flaps, maintaining your present airspeed and altitude." The student retracts the flaps and reduces power as he raises the aircraft pitch attitude. Pointing to the altimeter, which reads 100 feet below target altitude, the instructor comments, "You should have raised your pitch a little more - that was an Under Do with regard to the aircraft. Not a bad job though!" Recovery from slow flight is then initiated, and the airwork continues.

Enroute - VFR altitude

Over the water the student notices an increasing presence of clouds at their current altitude. He says to the instructor, "Soon we will be unable to maintain VFR at this altitude. Why don't we descend to 3,500 to get beneath these clouds." "Good observation and decision," the instructor replies. "Your repeated reviewing of the environment has helped you avoid getting into a poor judgment situation." The student maintains 3,500 feet and continues to head northwest away from the shoreline.

Enroute - Over Water

The instructor queries the student, "As a test of your problem resolving abilities tell me what would you do now if you lost all power and needed to make an immediate emergency landing?" The student thinks for a few moments, and then answers "I might have to ditch in the water. I'm afraid I wasn't paying attention, and possibly we are beyond our power-off gliding distance to land." The instructor pursues, "That's correct. In your favor, though, you have broken your poor judgment chain by correctly identifying your judgment error of flying an unknown distance from land. Now tell me, what was the subject area and the action way for this judgment?"

The student answers, "Well, the subject area is a combination of aircraft and environment because I didn't consider the limited gliding range of my aircraft in relation to how far I had travelled over water and away from land. The action way is Do. I

should not have let myself unintentionally get that far from land." The instructor replies, "Very good. You clearly understand your error. Let's call it a day. Head us back to the airport."

Debriefing

On the ground, the instructor and the student review the flight in a debriefing session. The instructor begins by saying, "You did pretty well today. I planned five judgment training activities for you, and you handled three of them correctly on your own: the missing screw for the fuel selector, the suggestion to fly at an incorrect altitude, and the encounter with clouds while VFR. You did fail to make proper use of the shoulder harness, and you almost let yourself get too far from land at one point." The instructor continues the discussion by describing how a poor judgment chain could develop if the pilot found himself over water with engine problems and could not glide back to land.

The "transitions using flaps" concept lesson is then discussed. The student is queried about which mental process he was using. "It seemed I was using automatic reaction," he says. The instructor then reviews the student's performance during the exercise, and provides any useful advice for possible improvements. At the end of the discussion, the instructor asks, "Do you remember having any hazardous thoughts during the flight?" The student says "No." The instructor then asks, "How about your stress level - did it ever increase to where you felt uneasy or distracted?" The student replies, "Most of the flight I was calm and doing fine. I did get a bit rattled after I realized I didn't know whether or not I could get back to land in an emergency situation. It didn't last very long, but I did think to relax myself and to deal with the situation at hand." The instructor positively affirms the student's self awareness of a change in stress level. He then declares that the flight has ended, and they make arrangements for the next training session.

APPENDIX C

DESCRIPTION OF OBSERVATION FLIGHT and OBSERVATION FLIGHT CHECKLIST

The scenario used by the instructor pilots as a standardization guide for the observation flights is represented on the following pages. Directions for the instructor, including feedback points, and a list of the situations to be administered, are included.

This appendix also reproduces the checklist used by both the observer and the instructor pilot during the observation flight.

Key To Abbreviations

Abbreviation	Meaning
DAB	Daytona Beach Regional Airport
NOTAMS	Notice to Airmen
NSB	New Smyrna Beach Municipal Airport
OK	Performance was satisfactory (okay)
PJ	Performance was not satisfactory (poor judgment)
SFB	Sanford Municipal Airport

DESCRIPTION OF OBSERVATION FLIGHT

SCENARIOS	SITUATIONS
Flight begins at Daytona Beach Aviation ramp. Instructor preparation in advance of student arrival includes: 1. Secure Jacksonville sectional chart. 2. Fuel aircraft & prep for flight. 3. NOTAM and weather check for NSB & SFB. 4. Set up preflight anomalies for test situation.	
Upon arrival, the student is briefed on: 1. Keeping the flight's activities confidential. 2. His or her role as pilot-in-command for the entire flight: "Do what you would normally do using your common sense." 3. Flight route: cross-country flight with landings at NSB, SFB. 4. Procedures in effect that may be unfamiliar to E-RAU students. 5. Flight instructor's introduction of possible poor judgment situations. 6. "Testing off" signals: verbal "My aircraft," "I mean it," <u>and</u> gesture with hands or physical contact.	
<u>DAB-GROUND</u>	
After briefing, the student is given the aircraft key. He or she is told to do a complete preflight and notify the instructor when ready to fly the cross-country. The student is reminded that he or she will be the pilot-in-command for the entire 2-hour flight.	
The student is expected either to look at a current Jacksonville <u>sectional chart</u> for airport information on New Smyrna Beach and Sanford or to verify with the instructor that the instructor will be acting as an information source for the two airports. The student does a complete	1. Flight Planning

preflight and must discover and correct all three anomalies which were prearranged. The student is debriefed on the preflight.

2. Preflight - through
** FEEDBACK

The "Entire Flight-Checklist" situation is observed by the instructor continuously until termination of the flight at DAB.

3. Checklist - Entire

The "taxi-controls for wind" situation is given at DAB while taxiing to runway. Instructor does debriefing on taxi exercise before allowing student to radio for takeoff clearance.

4. Taxi - Controls for Wind

DAB-NSB EN ROUTE

Flight proceeds via either of the south departure routes from DAB. En Route traffic avoidance is observed as the student navigates the frequently used low altitude airspace along the river. The student is told to make a landing at New Smyrna Beach as the flight passes south of the Port Orange bridge. Communication awareness is noted as the student sets up for the approach to NSB.

5. Traffic Avoidance

6. Communications Awareness

NSB-LANDINGS

In the traffic pattern, the "Radio Reports" situation is observed. After the landing, the student is directed to taxi on or across another runway to allow the "Taxi Across Runway" situation to be observed. A feedback briefing for situations 5, 6, 7, and 8 is given before takeoff.

7. Radio Reports

8. Taxi Across Runway
** FEEDBACK

NSB LOCAL

On takeoff, engine failure is simulated at 500 feet. Another landing approach is made where the instructor sets up a high approach situation by taking command and turning base leg abeam the runway threshold. A go-around is then made. Departure from the airport is made to the southeast to take the aircraft out over the ocean. The student is told to set up for slow flight and is observed traveling too far from land. (Instructor directs a turn back toward shore before aircraft does go beyond a safe gliding distance.)

9. Engine Failure
** FEEDBACK

10. High Landing Approach
** FEEDBACK

11. Over water flight
** FEEDBACK

Aircraft is headed southwest toward the Edgewater area where ground reference maneuvers at 800 feet are suggested over the congested area near Massey Ranch residential area.

12. Congested Area Maneuvers
** FEEDBACK

NSB/SFB EN ROUTE

The student is directed to head southwest to Sanford using the lakes as visual references. The student is told to climb to "cruise altitude." After cruise altitude is established and feedback is given, the student is told to plan for a landing at SFB. As a distraction from the evaluation activities, the student is told to practice finding ground reference points by looking for the fire tower or power lines between NSB and SFB.

13. En Route-Altitude
** FEEDBACK

SFB-LANDINGS

Contact is made with Sanford Tower, and the "Landing - Collision Avoidance" situation observed before the full stop landing.

14. Landing-Collision Avoidance
** FEEDBACK

Debriefing on 13 & 14 is given before takeoff. A slip demonstration - down to 100 feet, one wing-span from the runway edge, sets up the "Disturbed Approach" situation. The student should execute a go-around. A 030° departure heading is requested from the tower.

15. Disturbed Approach
** FEEDBACK

SFB-DAB EN ROUTE

The flight continues at 1500 feet past the undeveloped subdivisions until the north-south power lines. S-turns are directed (3 sets) then steep power turns while at 800 feet. An engine failure is simulated (throttle reduction), timed to make the field northwest (with powerlines) the best choice. The need for a 90° turn is simulated at 500 feet.

16. Low Altitude Airwork

17. En Route-Engine Failure

18. Low-Speed Turn

During recovery, the location and endurance situations are given, followed by feedback for 16, 17, 18, 19, and 20 during the flight back to Daytona.

19. En Route-Location

20. En Route-Endurance
** FEEDBACK

CHECKLIST: JUDGMENT SITUATIONS

Student____________________ Instructor____________________

Date____________________ Evaluator____________________

No.	SITUATION	OK	PJ	PLAN AT	DONE AT
1	Flight Planning (Sectional, NOTAMS, Weather)			DAB	
2	Preflight - Thorough (3 Anomalies)			DAB	
3	Entire Flight - Checklist			DAB	
4	Taxi - Controls for Wind			DAB	
5	Traffic Avoidance			DAB/NSB	
6	Communications Awareness			NSB	
7	Radio Reports			NSB	
8	Taxi Across Runway			NSB	
9	Engine Failure			NSB	
10	High Approach (Go Around)			NSB	
11	Over Water Flight			NSB-E	
12	Congested Area Maneuvers			NSB-S	
13	En route - Altitude			DAB/SFB	
14	Landing - Collision Avoidance			SFB	
15	Disturbed Approach Path			SFB	
16	Low Altitude Airwork			SFB/DAB	
17	En route - Engine Failure			SFB/DAB	
18	Low Speed/Low Altitude Turn			SFB/DAB	
19	En route - Location			SFB/DAB	
20	En route - Endurance			SFB/DAB	

APPENDIX D

WRITTEN PRETEST/POSTTEST

JUDGMENT TRAINING MATERIALS TEST

SECTION I

1. What three general areas should be of concern to the pilot who is using good judgment? Check one.

   _____ Lift, Drag, Thrust

   _____ Airspeed, Groundspeed, ETA

   _____ Pilot, Aircraft, Environment

   _____ Weight, Weather, Fuel

2. After a pilot makes a poor judgment, are the chances higher or lower that he will make another poor judgment?

   ____

3. What two sources of information can a pilot use to recognize poor judgment?

   ____

   ____

4. As a series of poor judgments increases in length, are the chances of continued safe flight increased or decreased?

   ____

5. Are there things a pilot can do to reduce stress while flying an aircraft?

   ____

6. Are there methods a pilot can use to decrease the chance of making a series of poor judgments while flying?

   ____

7. Read the following paragraph and circle the letter of the answer which best indicates how the pilot would react if he were thinking "Do something - quickly!"

> The pilot did not calculate fuel consumption correctly and did not bother to "top off" the tanks during his last stop. With 15 minutes of fuel left, he can make an emergency landing on an abandoned dirt road just below. A second option is to fly to an airfield which he thinks is ten minutes away.

A. He turns toward the airfield and looks for his sectional chart of the area.
B. He reduces his speed and altitude and looks for another emergency landing site.
C. He radios for assistance.
D. He lands on the dirt road with no further consideration of other alternatives.

8. Read the following paragraph and circle that letter of the answer which best indicates how the pilot would react if he were thinking "I can do it - I'm a good pilot."

> This non-instrument rated pilot is on a pleasure flight with three friends. He is advised that weather conditions are poor in the area where he is headed due to low clouds and showers. The excursion plan is to view some lakes and mountains in the vicinity.

A. The pilot goes to the area and dodges in and out of the clouds to give his passengers a view of the lakes.
B. The pilot decides to fly to the area anyway, figuring if his time is up, his time is up, no matter what the weather.
C The pilot changes plans and flies to another area where he hopes weather conditions are better.
D. The pilot disregards the weather advisory and flies to the edge of the mountains to see if he can avoid the weather.

9. Read the following paragraph and circle the letter of the answer which best indicates how the pilot would react if he were thinking, "Don't tell me."

> The pilot does not conduct a thorough preflight check. On takeoff he notices that his airspeed indicator is not working. Everything else seems normal. His friend, also a pilot, feels strongly that they should discontinue the flight and return to the airfield. The pilot then becomes upset with his friend.

A. The pilot starts banging the indicator to get it working.
B. The pilot tells his friend that it is okay to fly the plane anyway because the FARs are just rules to discipline pilots.
C. The pilot tells his friend that nothing will go wrong on the flight.
D. The pilot continues to become upset, but he does nothing because he feels there is no use trying to calm down his friend.

10. Read the following paragraph and circle the letter of the answer which best indicates how the pilot would react if he were thinking "It won't happen to me."

> On a pleasure flight, the pilot is showing his family some of the local sights. His eight-year-old son suggests that it would be great fun to fly under the large bridge ahead. His wife is upset at the idea, but his older son (age 16) dares him to do it.

A. The pilot decides to do it since he thinks it is really not all that risky.
B. The pilot quickly pulls the aircraft into a steep climbing turn to make the children forget about the bridge.
C. The pilot explains that it is illegal to do such a thing, but he does it anyway since no one is around to see.
D. The pilot flies past the bridge to be sure he can do it, then he flies under to show his family how confident he is of his flying skills.

SECTION II

Read the following pilot report. The report is by a pilot who got into trouble because of his poor decision making about preflight activities and the operation of an aircraft system.

After reading the report you will be asked questions regarding the pilot's judgment. The sentences are numbered for your convenience.

Pilot's Report

(1) I taxied out of the loading area about 15 minutes later than I had planned. (2) When I got about 1,000 feet down the taxiway, the tower called me. (3) They said that they thought they could see smoke coming from my left wheel assembly. (4) I did not want to stop and check out the problem because I was determined to get to Birmingville on time to impress my boss. (5) I figured I should do something right away to get the tower off my back, so I decided to speed up. (6) I thought maybe the rush of air would blow away the smoke that had attracted the tower's attention.

(7) Then the left wheel started binding up a little. (8) The airplane was moving pretty fast, and I was having a hard time steering it in a straight line. (9) The dim taxiway lights did not help matters any. (10) Before I really knew what was happening, the left wheel was off the taxiway and into the grass. (11) I closed the throttle and tried to stop as fast as I safely could, but the brakes were not working on the left side. (12) By then I figured there was nothing I could do to overcome this run of bad luck, so I figured I would just bring the plane to a stop as best I could. (13) I was so busy cursing my bad luck that I did not notice the underground fuel system box sticking up until it was too late. (14) I hit the box at only about 5 miles per hour, but that was fast enough to do substantial damage to the landing gear. (15) It really makes me mad to think that the whole thing was due to a hydraulic fluid leak in the brake system. (16) I probably would have noticed it if I had done my usual preflight inspections.

****

1. Consider sentence 4. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

2. Consider sentence 5. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

3. Consider sentence 6. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

4. Consider sentence 7. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

5. Consider sentence 11. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

6. Consider sentence 12. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

7. Consider sentence 13. Check the statement which best represents the pilot's judgment.

_____ Good judgment

_____ Poor judgment

_____ No judgment in this sentence

_____ Cannot tell

SECTION III

Read the pilot judgment scenario below. After you have finished reading, you will be asked a series of questions about factors contributing to the pilot's judgment. (The sentences are numbered to assist you in answering the questions.)

Pilot Judgment Scenario

(1) Stan Siler is a 19 year old college student at home enjoying a summer break from classes. (2) Stan is a non-instrument rated private pilot with 156 hours of flying time. (3) Stan's father owns a new single engine aircraft, and Stan has flown it 35 hours this summer.

(4) Around 4:00 p.m., Stan receives a telephone call from his girlfriend who is attending summer classes at State University. (5) She tells him there is going to be a party at her sorority house that night. (6) She asks if he can get the family airplane and fly to Capital City to accompany her to the party.

(7) Stan has not seen her for three weeks, and he tells her he will come. (8) He asks her to meet him at the airport at 7:00 p.m. (9) Before hanging up, Stan asks her how the weather is there. (10) She says the sun has been out most of the afternoon.

(11) Arriving at Hometown airport about 5:30 p.m., Stan carefully preflights the airplane. (12) Since his girlfriend said that the weather was good at Capital City, and since it is nice and clear locally, he does not check the aviation weather forecast. (13) Stan knows the 120 mile flight to Capital City will take just over one hour. (14) At 5:45 p.m., Stan takes off with 2-½ hours of fuel onboard.

(15) About 50 miles from Capital City, Stan sees thick clouds ahead and to the east. (16) About 35 miles out of Capital City, Stan finds he is encountering an increasing amount of clouds at his cruising altitude of 3,000 feet. (17) Stan continues on course, but he reduces his altitude to about 1,500 feet to stay below the clouds. (18) Ten minutes later Stan is once again dodging clouds, and he is concerned enough to radio the Capital City FSS. (19) He is told that the airport has recently gone below VFR minimums. (20) He is directed to a small airport about 15 miles west of his current position for an alternate landing.

(21) Stan now reduces his altitude to 600 feet to stay out of the clouds, and he knows he must maintain at least 500 feet to stay above local hills. (22) With clouds closing in on all sides, Stan considers making an immediate forced landing rather than continuing on another 10 miles or so in search of the unfamiliar alternate airport.

(23) Seeing a long, level field below him, Stan flies over it once to check for obstacles. (24) Finding it clear, Stan executes an emergency landing using proper procedures. (25) Stan makes a good landing, but the heavy rains have made the recently cultivated field very muddy. (26) Shortly after the wheels encounter the soft mud, the aircraft noses over.

****

Questions

Use the two following scale systems to answer all of the questions.

A. Importance Scale: What level of importance would you rate each of the factors listed in the question if you were in the same situation as the pilot in the scenairo? Use a scale of 0 to 10: 10 = utmost importance, 0 = absolutely no importance. You may use the same scale number more than once.

B. Certainty Scale: How certain are you of the importance rating you gave to the factor listed to the left? Use this scale: 3 = absolutely certain; 2 = pretty sure; 1 = unsure; 0 = just guessing.

Question Series 1.

Look at sentence 12, and consider Stan's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Weather information at airport	______	______
b. Time the party starts	______	______
c. Experience in this type aircraft	______	______
d. Weather information from girlfriend	______	______
e. Type of aircraft	______	______

Question Series 2.

Look at sentence 17, and consider Stan's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Flying time to destination	______	______
b. Type of aircraft	______	______
c. Cloud cover in area	______	______
d. VFR flight rules	______	______
e. Reason for trip	______	______

Question Series 3.

Look at sentence 19, and consider Stan's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Area weather conditions	______	______
b. Fuel on board	______	______
c. Distance from destination	______	______
d. Time of day	______	______
e. Radio contact currently available	______	______

Question Series 4.

Look at sentence 22, and consider Stan's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Pilot's total flying time	______	______
b. Area weather conditions	______	______
c. Time of day	______	______
d. Location of alternate airport	______	______
e. Regulations for VFR flight	______	______
f. Estimated arrival time	______	______
g. Type of aircraft	______	______
h. Condition and contour of local terrain	______	______
i. Capital City ATIS information	______	______
j. Instruments on board aircraft	______	______

Pilot Judgment Scenario No. II.

(1) The pilot was on a cross-country flight in a high performance, single-engine airplane. (2) The weather was VFR, and he was cruising at 5,500 MSL. (3) The ground below consisted of rolling, tree-covered hills interspaced with what seemed to be grassy clearings. (4) All appeared well until the fuel pressure dropped, and engine power decreased suddenly. (5) The pilot immediately switched fuel tanks and turned on the auxiliary boost pumps. (6) The engine regained power, and the pilot climbed to a higher altitude.

(7) As the pilot applied climb power, the engine once again began to malfunction. (8) This time the power loss was complete. (9) A minute passed before the pilot realized that there was not a suitable landing area within gliding distance.

(10) A glance at the air speed indicator shocked him back to reality. (11) The air speed had already decreased to ten mph below best glide speed, and the VSI was showing a descent of 1,100 fpm -- 500 feet of precious altitude had already been lost. (12) The pilot got hold of himself and established power-off best glide speed, selected a landing area, and established a pattern. (13) He recalled his "simulated" engine failures, but this was for real! (14) Now, at only 4,000 feet and with the VSI reading an uncomfortable 750 fpm, the pilot had roughly five minutes to go. (15) He considered a landing in the tops of the smaller trees. (16) The airplane would probably be heavily damaged, but at least he would walk away. (17) He thought again about the probable damage and about the possibility of never flying again. (18) No, the trees were out - he would try for one of the small clearings. (19) Still maintaining glide speed as he turned onto final approach, it became apparent that he would clear the trees. (20) The pilot lowered the landing gear and dove the aircraft toward the clearing. (21) The aircraft picked up speed and struck the ground hard on the main gear, tearing it away. (22) What had appeared to be a relatively smooth surface from the air was actually uneven and strewn with rocks. (23) The aircraft slid to a stop on its belly. (24) The pilot restrained only by a seatbelt, jacknifed into the control panel, sustaining severe head and facial injuries.

****

<u>Questions</u>

Use the two following scale systems to answer all of the questions.

A. <u>Importance Scale:</u> What level of importance would you rate each of the factors listed in the question <u>if you were in the same situation as the pilot in the scenario</u>? Use a scale of 0 to 10: 10 = utmost importance, 0 = absolutely no importance. You may use the same scale number more than once.

B. Certainty Scale: How certain are you of the importance rating you gave to the factor listed to the left? Use this scale: 3 = absolutely certain; 2 = pretty sure; 1 = unsure; 0 = just guessing.

Question Series 5

Look at sentence 5 and consider the pilot's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Airspeed	________	________
b. Carb Heat	________	________
c. Altitude	________	________
d. Weather	________	________

Question Series 6

Look at Sentence 9 and consider the pilot's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Altitude	________	________
b. Wind	________	________
c. Airspeed	________	________
d. Radio	________	________
e. Engine Restart	________	________

Question Series 7

Look at Sentence 12 and consider the pilot's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

	Importance	Certainty
a. Airspeed	________	________
b. Altitude	________	________
c. Wind	________	________
d. Radio	________	________
e. Terrain	________	________

Question Series 8

Look at Sentence 18 and consider the pilot's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

		Importance	Certainty
a.	Aircraft Damage	______	______
b.	Filing Accident Report	______	______
c.	Personal Injury	______	______
d.	Airspeed	______	______
e.	Altitude	______	______
f.	Engine Restart	______	______
g.	Shutdown Checklist	______	______

Question Series 9

Look at Sentence 20 and consider the pilot's situation. Use the Importance Scale and the Certainty Scale to rate the following factors:

		Importance	Certainty
a.	Airspeed	______	______
b.	Altitude	______	______
c.	Aircraft Damage	______	______
d.	Personal Injury	______	______
e.	Engine Restart	______	______
f.	Shutdown Checklist	______	______

SECTION IV

ACTION WAYS QUESTIONS

1. In each of the six paragraphs below, underline the phrase which indicates a poor judgment action by the pilot.

2. In the right margin, briefly state why the action indicates poor judgment.

The aircraft was placarded against takeoff or approaches using the auxiliary fuel tank. The pilot took off with the engine feeding from the auxiliary fuel tank. The engine failed shortly after takeoff.

This pilot did only part of the recommended preflight checks. He attempted to abort his takeoff when he noticed the controls were binding. The pilot lost control, and the airplane slid off the end of the runway. Investigation revealed that the seat belt in the rear cockpit was tied to the control stick.

The cabin door came open in flight, and the passenger panicked. The pilot immediately decided he could not correct the situation in the air and attempted an emergency landing on a road. The aircraft slid off the narrow dirt road into a ditch.

The pilot hurried through preflight, yet he did everything on the checklist. After about ten minutes of flight the pilot experienced partial loss of power and made an emergency landing. A careful inspection revealed the power loss was due to fuel contamination and water was found in the fuel line.

The pilot was taking his passenger for a low flight over some fields and was flying downwind. He pulled up rather sharply. The combination of the aircraft's low altitude and its relatively fast ground speed led the pilot to believe that his airspeed was adequate. During the sharp pullup, the aircraft stalled and spun into the ground.

The pilot made an approach to the 3200-foot landing strip in strong, gusty wind. At the beginning of the flare a wind gust caused the pilot to have difficulty in controlling the aircraft. After struggling to get the aircraft settled down onto the runway, he decided to go around. The aircraft was unable to gain sufficient altitude to clear power lines at the departure end of the runway.

SECTION V

1. Can more than one subject area be involved in pilot judgment?

2. Define Action Way.

3. What are the 6 Action Ways?

4. Describe each of the 6 Action Ways.

5. What is a Poor Judgment Chain?

6. Are there steps a pilot can take to break a Poor Judgment Chain?

7. What are the 3 mental processes of safe flight?

8. Write the abbreviations for the 3 mental processes of safe flight.

____

____

9. Define each of the 3 mental processes of safe flight.

____

____

____

____

____

10. Can anyone have a hazardous thought?

____

____

11. What are the 5 hazardous thoughts?

____

____

____

12. The pilot does not conduct a thorough preflight check. On takeoff he notices that his airspeed indicator is not working. Everything else seems normal. His friend feels strongly that they should discontinue the flight and return to the airfield. The pilot then becomes upset with his friend. Which of the following alternatives best illustrates the anti-authority reaction?

   a. The pilot tells off the friend for butting in.

   b. The pilot starts banging the indicator to get it working.

   c. The pilot tells his friend that it is okay to fly the airplane anyway, because the FARs are just rules to discipline pilots.

   d. The pilot tells the friend that nothing will go wrong on the flight.

   e. The pilot continues to become upset, but he does nothing, because he feels there is no use trying to calm down his friend.

13. The pilot failed to conduct a thorough preflight check. On takeoff he notices that his airspeed indicator is not working. Everything else seems normal. His friend feels strongly that they should discontinue the flight and return to the airfield. The pilot then becomes upset with his friend. Which of the following alternatives best illustrates the impulsivity reaction?

   a. The pilot tells off the friend for butting in.

   b. The pilot starts banging the indicator to get it working.

   c. The pilot tells his friend that it is okay to fly the airplane anyway, because the FARs are just rules to discipline pilots.

   d. The pilot tells the friend that nothing will go wrong on the flight.

   e. The pilot continues to become upset, but he does nothing, because he feels there is no use trying to calm down his friend.

14. The pilot failed to conduct a thorough preflight check. On takeoff he notices that his airspeed indicator is not working. Everything else seems normal. His friend feels strongly that they should discontinue the flight and return to the airfield. The pilot then becomes upset with his friend. Which of the following alternatives best illustrates the invulnerability reaction?

   a. The pilot tells off the friend for butting in.

   b. The pilot starts banging the indicator to get it working.

   c. The pilot tells his friend that it is okay to fly the airplane anyway, because the FARs are just rules to discipline pilots.

   d. The pilot tells the friend that nothing will go wrong on the flight.

   e. The pilot continues to become upset, but he does nothing, because he feels there is no use trying to calm down his friend.

15. The pilot failed to conduct a thorough preflight check. On takeoff he notices that his airspeed indicator is not working. Everything else seems normal. His friend feels strongly that they should discontinue the flight and return to the airfield. The pilot then becomes upset with his friend. Which of the following alternatives best illustrates the macho reaction?

    a. The pilot tells off the friend for butting in.

    b. The pilot starts banging the indicator to get it working.

    c. The pilot tells his friend that it is okay to fly the airplane anyway, because the FARs are just rules to discipline pilots.

    d. The pilot tells the friend that nothing will go wrong on the flight.

    e. The pilot continues to become upset, but he does nothing, because he feels there is no use trying to calm down his friend.

16. The pilot failed to conduct a thorough preflight check. On takeoff he notices that his airspeed indicator is not working. Everything else seems normal. His friend feels strongly that they should discontinue the flight and return to the airfield. The pilot then becomes upset with his friend. Which of the following alternatives best illustrates the external control reaction?

    a. The pilot tells off the friend for butting in.

    b. The pilot starts banging the indicator to get it working.

    c. The pilot tells his friend that it is okay to fly the airplane anyway, because the FARs are just rules to discipline pilots.

    d. The pilot tells the friend that nothing will go wrong on the flight.

    e. The pilot continues to become upset, but he does nothing, because he feels there is no use trying to calm down his friend.

Write the antidote for the following thoughts:

17. Anti-authority - "Don't tell me!"

18. Impulsivity - "Do something - quickly!"

19. Invulnerability - "It won't happen to me!"

20. Macho - "I can do it!"

21. External Control - "What's the use?"

APPENDIX E

PRETEST/POSTTEST ANSWER KEY

SECTION I (11 points)

1. Pilot, Aircraft, Environment
2. Higher
3. Self (1 point)
   Outside source (1 point)
4. Decreased
5. Yes
6. Yes
7. D
8. E
9. B
10. A

SECTION II (7 points)

1. Poor Judgment
2. Poor Judgment
3. Poor Judgment
4. No Judgment in this sentence
5. Good Judgment
6. Poor Judgment
7. Poor Judgment

SECTION III

Scores for section III were obtained by the means of student responses to questions 2C, 3A, 3B, 4H, 6A, 6C, 6E, 7A, 7B, 7E, 9A, 9D. These are the questions on which the experts had consensus.

SECTION IV (12 points)

(Underline Phrase = 1 Point)
(Choose Action Way= 1 Point)

1. The pilot took off with the engine feeding from the auxiliary fuel tank.

DO

2. This pilot did only part of the recommended preflight checks.

NO DO

3. The pilot immediately decided he could not correct the situation in the air and attempted an emergency landing on a road.

EARLY DO

4. The pilot hurried through preflight.

UNDER DO

5. He pulled up rather sharply.

OVER DO

6. After struggling to get the aircraft settled down onto the runway, he decided to go around.

LATE DO

SECTION V (Max. = 41)

1. Yes

2. Action which is a result of Poor Judgment

3. DO, NO DO, OVER DO, UNDER DO, EARLY DO, LATE DO

4. DO --------------- Did something you should not have
OVER DO --------------- Did too much
EARLY DO --------------- Acted too early
NO DO --------------- Did not do something you should have
UNDER DO --------------- Did not do enough
LATE DO --------------- Acted too late

5. Series of errors in Judgment

6. Yes

7. Automatic Reaction, Repeated Reviewing, Problem Resolution

8. AR, RR, RP

9.

	AR	-	Maintain ongoing control of the aircraft and respond to emergencies
Mode of Thinking that:	PR	-	Used to overcome undesirable situations by means of systematic process
	RR	-	Keeps you constantly aware of all factors that contribute to safe flight (P,A,E)

10. Yes

11. Anti-authority, Macho, External Control, Invulnerability, Impulsivity

12. C

13. B

14. D

15. A

16. E

17. Use the rules: they are usually right

18. Not so fast. Think first.

19. Why not me? I am human, too.

20. Risks don't make my fly better. They make me a fool.

21. I'm not helpless. I can make a difference.

APPENDIX F

TRAINING SCHEDULE FOR FLIGHT PORTIONS AND GROUND SCHOOL

This appendix represents the schedule form used by the flight instructors in the judgment program to monitor the subjects' progress. It includes checkpoints for work in the Student Manual and indicates points at which flight lessons are to be administered. It is to be noted that the in-flight lesson schedule presented here was established for use in conjunction with the evaluation experiment only. The Instructor Manual describes the appropriate scheduling of training activities for use in field-implemented flight training programs.

JUDGMENT TRAINING PROJECT

STUDENT PROGRESS RECORD

Student Manual Lesson	Student's Time to Complete	Written Exercises: Lesson Has	Written Exercises: Check Done	Student/Instructor Contacts: Required	Student/Instructor Contacts: Actual Time	Remarks
1		No		No		
2		No		No		
3		Yes		No		
UNIT I TOTAL		---	---	---		Complete Unit I before In-Flight lesson 1
4		Yes		No		
5		Yes		No		
6		Yes		No		
7		Yes		No		
8		Yes		No		
9		Yes		No		
10		Yes		No		
11		Yes		Yes		
12		No		No		
13		Yes		Yes		
UNIT II TOTAL		---	---	---		Complete Unit II before In-Flight lesson 2
14		Yes		Yes		
15		Yes		Yes		
16		Yes		Yes		
17		Yes		Yes		
18		Yes		Yes		
UNIT III TOTAL		---	---	---		Complete Unit III before In-Flight lesson 3
GRAND TOTAL						

APPENDIX G

STATISTICAL ANALYSIS PROCEDURES

In presenting data in this report, several types of statistics are used. Description statistics include the arithmetic mean (M), and the standard deviation (SD). The M is commonly known as "the average", and the SD is a measure which indicates variability of individual scores about the M.

In evaluating whether two or more sets of data (e.g., group E pretest, group E posttest, group Ca pretest, group Ca posttest) differ to a degree greater than might be expected by chance alone, statistical tests of significance are used. In this report "analysis of variance (ANOVA)" is the primary statistical test.

The amount of departure from chance expectation is expressed in terms of probability statements. The expression $p < 0.05$ means that the probability that the difference is due to chance alone is less than 5 in 100. The smaller the probability figure, the less likely it is that differences are due to chance variation and the more likely it is that the differences are statistically significant.

The ANOVA test yields a statistic called the F ratio, which is the ratio of two variance estimates. It is this F ratio which allows the probability statement to be made. In the ANOVA, reference is made to df, or degrees of freedom. This value refers to the number of independent measures on which the test is based.

The reader desiring more information on the subject of statistical analysis is referred to any one of numerous standard statistical textbooks. For example:

1. Myers, J.L. Fundamentals of Experimental Design. Allyn and Bacon, Inc., Boston: 1972.

2. Runyan, R.P., and Haber, A. Fundamentals of Behavioral Statistics. Addison-Wesley, Reading, MA: 1971.

APPENDIX H

PANEL OF EXPERTS INFORMATION

The panel of experts for the scenario analysis portion of the written test included persons with the following aviation backgrounds:

- 4 - test pilots from the FAA Technical Center
- 3 - captains from commercial airlines with flight instruction and safety supervision experience
- 2 - flight instructors at major universities
- 1 - manager of safety for a corporate aircraft manufacturer
- 1 - editor of an aviation magazine
- 1 - chief pilot for a private corporation

APPENDIX I

DEMOGRAPHIC DATA FOR EVALUATION EXPERIMENT SUBJECTS

This appendix contains three demographic data tables, one each for the subjects in groups E, Cf, and Ca. Data for groups E and Cf were obtained primarily from the interview after their observation flight. All data for group Ca and additional data for groups E and Cf were obtained from a research subject information sheet which was completed by each subject at the beginning of the study.

The appendix also contains the end of experiment interview form employed by the interviewer to record the information, and it contains the student attitude questionnaire form administered to group E subjects during the interview.

REMARKS REGARDING INFORMATION REPORTED.

Data for item 5 on the interview form, "Time in U.S." (for non-U.S. citizens), were not reported in the tables to avoid the possibility of identifying specific subjects.

Data for item 6 on the interview form, "Academic Major," were not reported in the tables because all subjects except for one were Aeronautical Science majors (group E contained one Computer Science major). At Embry-Riddle Aeronautical University, the Aeronautical Science major includes studies in general college education subjects plus the operational and management aspects of the aviation industry. In addition, all students receive flight training which, upon graduation, qualifies them to be examined for the FAA Commercial Pilot Certificate with Instrument and Multi-Engine ratings.

Flight hour data was collected at beginning and ending points of the evaluation experiment. The data reported in the "Flight Hours - Begin" column of the tables were collected on September 30, 1981. The written pretests for subjects in groups E and Ca were administered on October 1 and 2, 1981. The data reported in the "Flight Hours - End" column of the tables were collected on November 6, 1981. The written posttests were administered on November 17 and 18, 1981. Judgment flight training for the group E subjects was administered during the period beginning October 5, 1981 and ending November 6, 1981. The observation flights for the group E and group Cf subjects were administered during the period November 9, 1981 through November 25, 1981.

TABLE I-1: DEMOGRAPHIC DATA: GROUP E

Subject Number	Age	Sex	Citizen-ship	GPA*	Flight Hours: Begin	End
1	17	F	U.S.	3.0	37.0	56.3
2	25	M	U.S.	2.5	16.8	37.8
3	18	F	U.S.	3.5	21.7	30.6
4	18	M	U.S.	3.0	31.0	52.7
5	19	M	U.S.	2.7	12.1	23.8
6	19	M	U.S.	2.8	26.7	42.4
7	23	M	U.S.	2.7	38.8	57.8
8	21	M	U.S.	2.5	113.2	141.0
9	19	M	U.S.	2.1	44.3	57.9
10	18	M	U.S.	3.0	18.1	26.3
11	19	M	U.S.	3.7	25.4	71.1
12	18	M	U.S.	2.5	30.8	57.2
13	19	M	U.S.	2.8	15.9	42.4
14	17	M	U.S.	3.3	35.6	59.2
15	20	M	U.S.	3.6	139.2	158.9
16	19	M	U.S.	3.8	19.0	42.2
17	20	M	U.S.	2.6	79.9	97.2
18	19	F	U.S.	3.4	62.9	83.4
19	19	M	U.S.	2.9	20.2	49.1
20	19	M	U.S.	3.3	35.8	43.3
21	20	M	U.S.	2.5	18.0	29.8
22	20	M	U.S.	3.2	27.1	34.6
23	19	M	U.S.	2.8	20.7	39.1
24	19	M	U.S.	3.7	22.1	50.9
25	23	M	U.S.	2.8	38.3	45.8
26	19	M	U.S.	4.0	48.0	54.0
Mean	19.46	(11.5% Female)	(0.0% Non-US)	3.03	38.41	57.11
Standard Deviation	1.82			0.49	30.22	32.07

Group E: N = 26
* = College Grade Point Average (4.0 = A)

TABLE I-2: DEMOGRAPHIC DATA: GROUP Ca

Subject Number	Age	Sex	Citizen-ship	GPA*	Flight Hours: Begin	End
27	19	M	U.S.	2.7	21.3	34.9
28	26	M	U.S.	2.4	29.7	38.4
29	19	M	U.S.	2.2	30.2	30.2
30	20	M	U.S.	2.0	22.8	25.7
31	20	M	U.S.	3.0	19.3	42.6
32	18	M	*	3.4	15.4	19.0
33	18	M	*	3.2	35.0	40.9
34	21	M	U.S.	2.3	10.0	22.0
35	19	M	U.S.	3.6	19.1	23.6
36	19	M	U.S.	2.9	27.4	73.4
37	19	M	U.S.	3.6	43.1	71.0
38	18	M	U.S.	2.6	19.3	35.9
39	20	M	U.S.	2.6	29.2	36.2
40	20	M	U.S.	3.5	23.3	51.8
41	19	F	U.S.	1.9	47.0	61.5
42	21	M	U.S.	2.0	52.7	52.7
43	24	M	U.S.	3.3	43.2	58.1
44	17	F	*	2.7	24.8	32.6
45	20	M	U.S.	2.7	19.5	24.9
46	23	M	U.S.	3.0	20.7	40.7
47	19	M	U.S.	3.0	25.7	33.0
48	19	M	U.S.	3.3	25.4	55.8
49	20	M	U.S.	3.2	41.4	60.0
50	23	M	U.S.	3.5	91.9	116.1
51	18	M	U.S.	3.4	27.0	47.0
Mean	19.96	(8% Female)	(12% Non-US)	2.88	30.58	45.12
Standard Deviation	2.09			0.53	16.51	21.15

Group Ca: N = 25

* = College Grade Point Average (4.0 = A)

TABLE I-3: DEMOGRAPHIC DATA: GROUP Cf

Subject Number	Age	Sex	Citizen-ship	GPA*	Flight Hours: Begin	End
52	19	M	U.S.	3.3	47.9	82.7
53	19	M	U.S.	2.5	30.2	55.6
54	18	M	U.S.	3.6	73.0	82.0
55	18	M	U.S.	3.1	22.8	48.4
56	20	M	*	2.2	103.2	128.4
57	19	M	U.S.	2.5	44.4	50.7
58	20	M	U.S.	3.0	36.4	36.4
59	18	M	U.S.	3.0	16.0	28.1
60	19	M	*	3.2	22.1	23.5
61	19	M	U.S.	3.8	23.6	44.2
62	20	M	U.S.	2.5	42.1	43.7
63	19	M	U.S.	2.9	18.9	34.5
64	18	M	U.S.	3.0	25.0	25.0
65	18	M	U.S.	2.0	21.7	46.8
66	21	M	U.S.	3.0	89.6	104.9
67	19	M	U.S.	4.0	33.9	54.6
68	23	M	U.S.	2.9	20.7	25.9
69	20	M	U.S.	2.5	56.0	89.0
70	18	M	U.S.	2.8	17.3	17.3
71	27	M	U.S.	3.0	43.6	44.3
72	18	M	U.S.	3.0	20.3	20.3
73	19	M	U.S.	3.1	19.4	52.0
74	17	M	U.S.	2.0	23.5	27.4
75	20	M	U.S.	2.7	39.0	45.0
Mean	19.40	(0.0% Female)	(8.3% Non-US)	2.90	37.11	50.45
Standard Deviation	2.04			0.50	23.11	28.17

Group Cf: N = 24
* = College Grade Point Average (4.0 = A)

END OF EXPERIMENT INTERVIEW

1. NAME ______________________________

2. AGE ______________________ 3. SEX ______________

4. CITIZENSHIP ______________________________

5. TIME IN U.S. ______________________________

6. ACADEMIC MAJOR ______________ 7. G.P.A. ______________

QUESTIONS 8-18 ARE FOR GROUP E ONLY.

8. Was the effort required to complete the manual too time consuming?

9. Was the time spent in judgment flight training

   a. too little?

   b. too much?

   c. about right?

10. How would you like to see the program changed?

11. Which areas would you emphasize:

   a. more?

   b. less?

12. Has this program had any impact on your judgment-making behaviors thus far? What were the circumstances?

13. Were you asked anything on the written test that you were not familiar with?

14. Did you understand all of the questions?

15. Did you have ample opportunity to meet with your instructor?

16. How do you feel about each of the following as they relate to pilot judgment.

    a. Hazardous thoughts and antidotes

    b. Action ways

    c. Mental processes of safe flight

    d. Subject areas

17. Do you feel this program will be valuable to you in your future flying?

    Why?

18. Complete the attitude questionnaire.

QUESTIONS 19-22 ARE FOR GROUPS E AND Cf

19. Heard about the check flight before?

20. In situations where the IP (instructor pilot) indicated you made a poor judgment did you think you were coerced or forced into the maneuver?

21. Were there any situations you thought were unfair or overly confusing?

22. Were there any maneuvers or procedures requested of you with which you were not familiar?

STUDENT ATTITUDE QUESTIONNAIRE

	SA	A	N	D	SD
(1) In the future I am going to pay more attention to the judgment concepts covered in my own flying.					
(2) This program, as a whole, is a good idea.					
(3) I'd like to see material like this included as a requirement for a private pilot license.					
(4) The instructor pilot really kept me aware of judgment factors during the training flights.					
(5) I feel talking about judgment with the instructor pilot is an important part of learning good judgment.					
(6) I would have learned just as much about judgment if there were no flying.					
(7) The course moved too fast and covered too many concepts.					
(8) The stress reduction lesson was helpful.					

* * * * * * * * *

KEY:

SA: Strongly Agree

A: Agree

N: No Opinion

D: Disagree

SD: Strongly Disagree